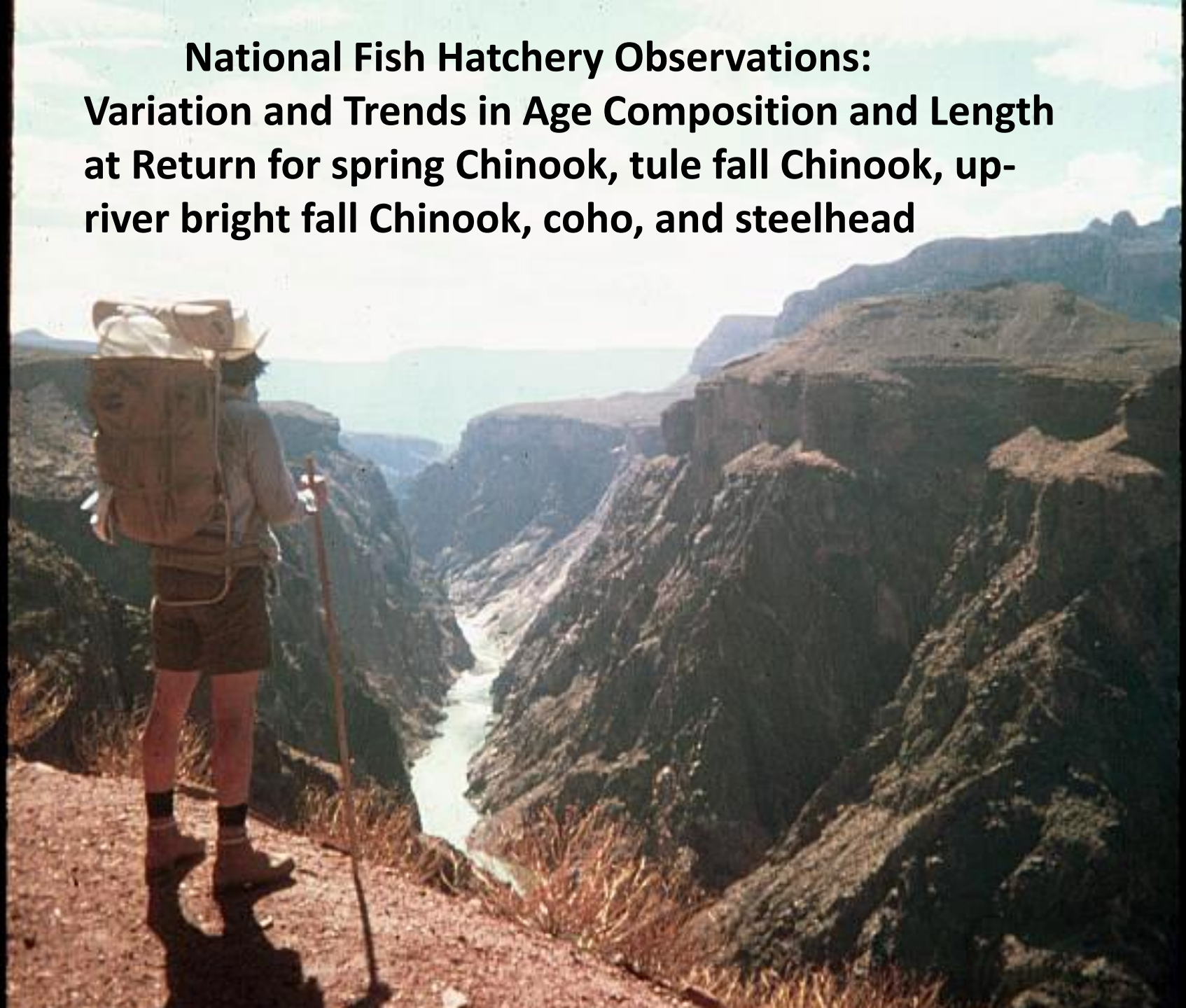
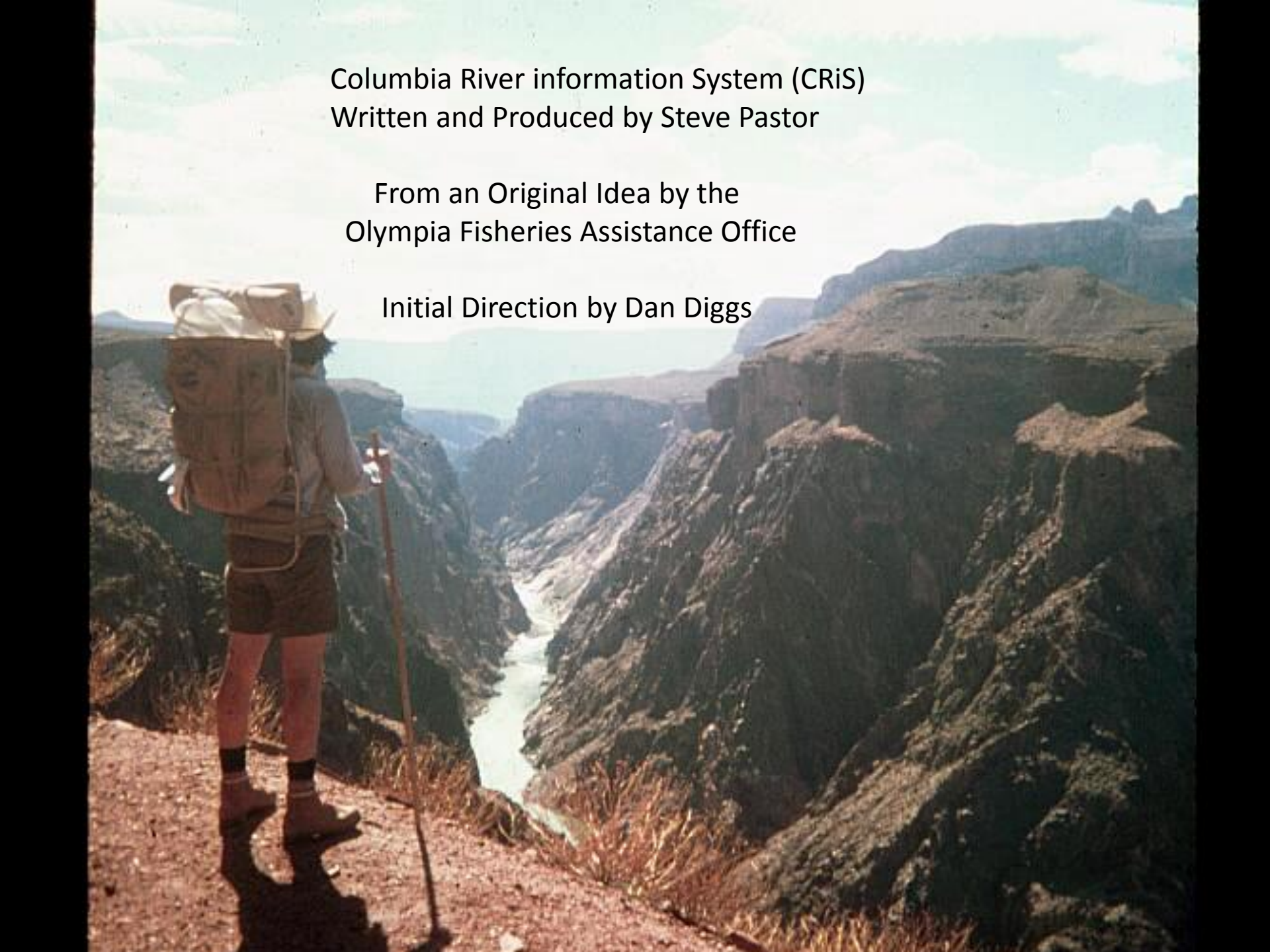
National Fish Hatchery Observations: Variation and Trends in Age Composition and Length at Return for spring Chinook, tule fall Chinook, up-river bright fall Chinook, coho, and steelhead





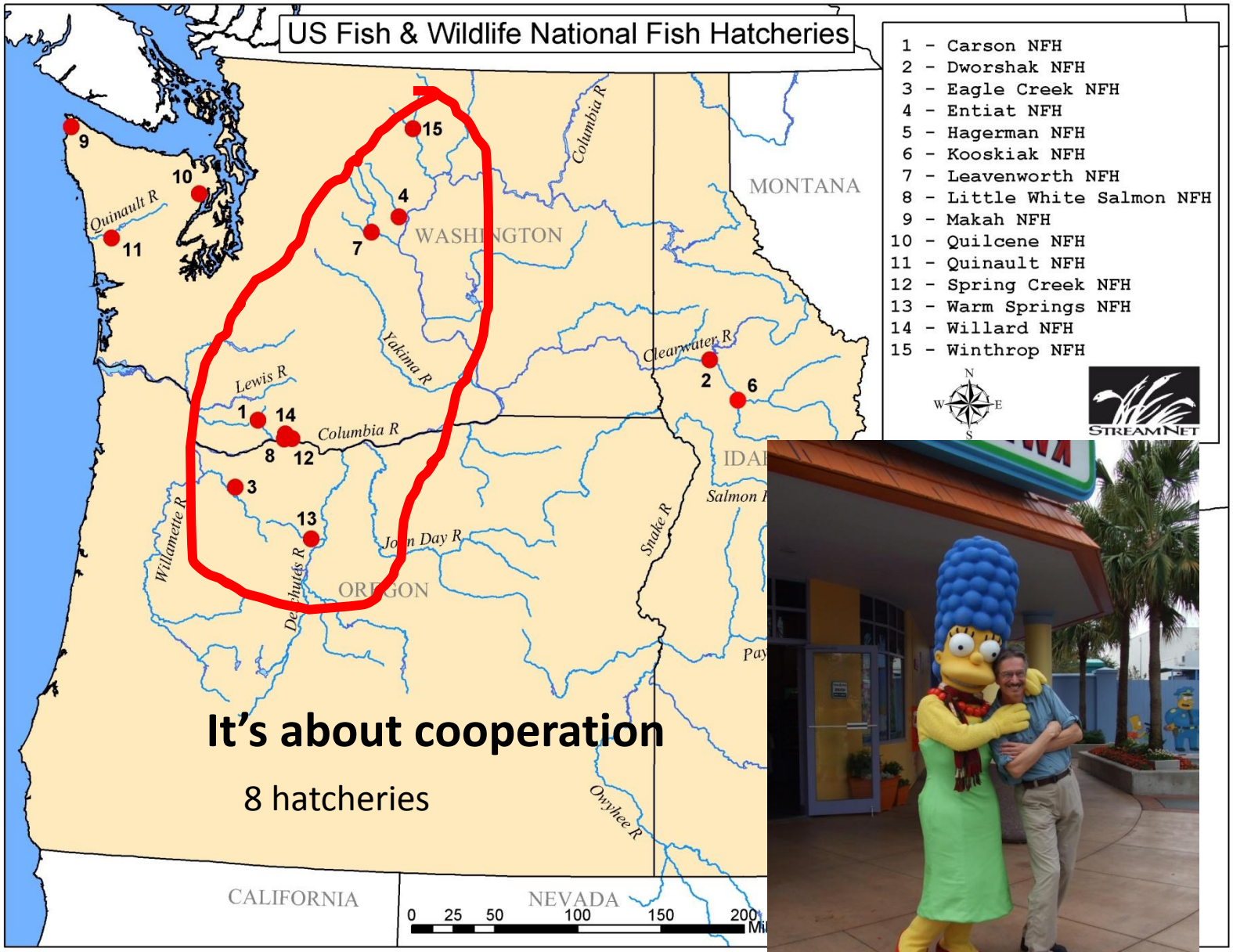
Columbia River information System (CRiS)
Written and Produced by Steve Pastor

From an Original Idea by the
Olympia Fisheries Assistance Office

Initial Direction by Dan Diggs

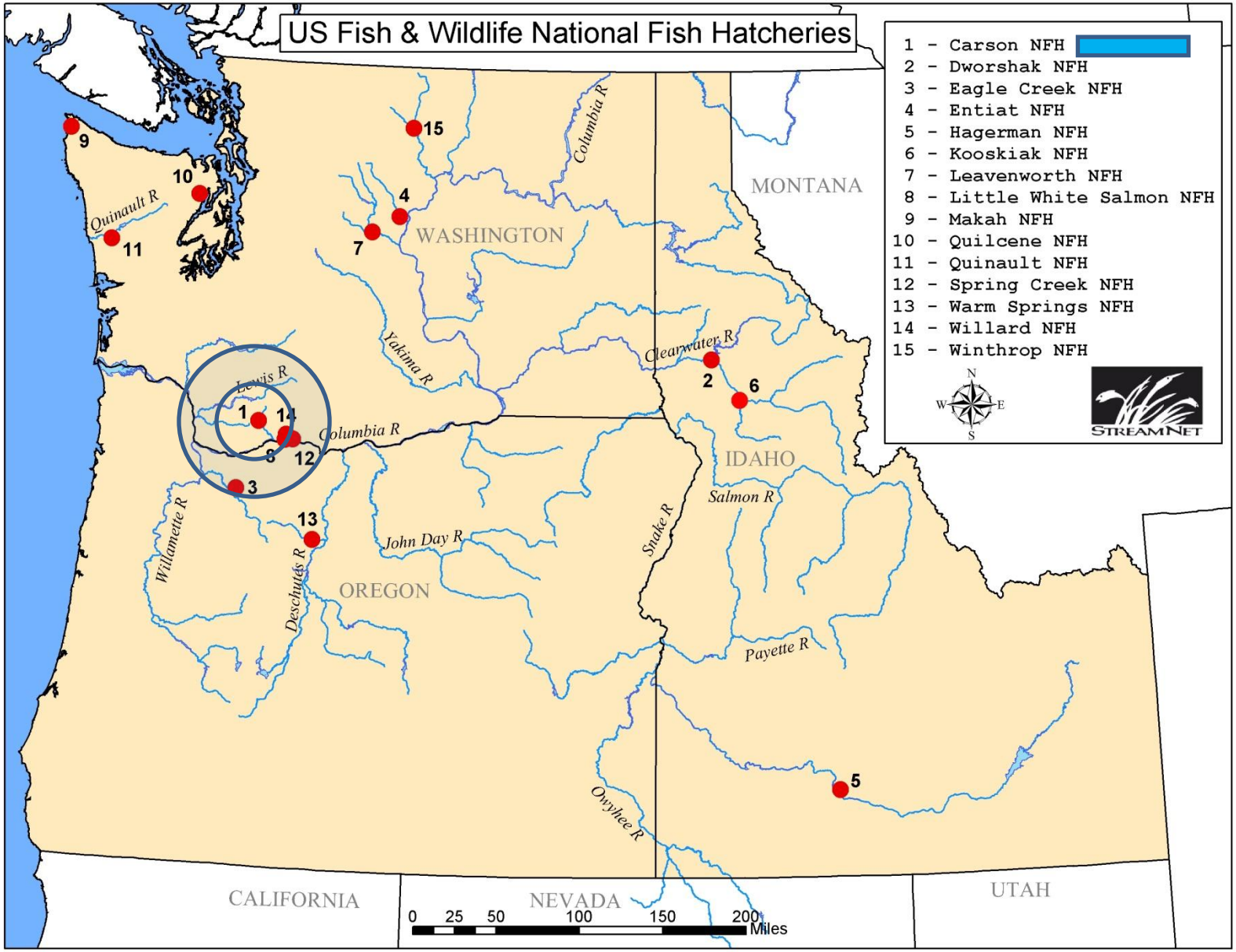
Biosample, Coded-wire Tag and Age Data Entry

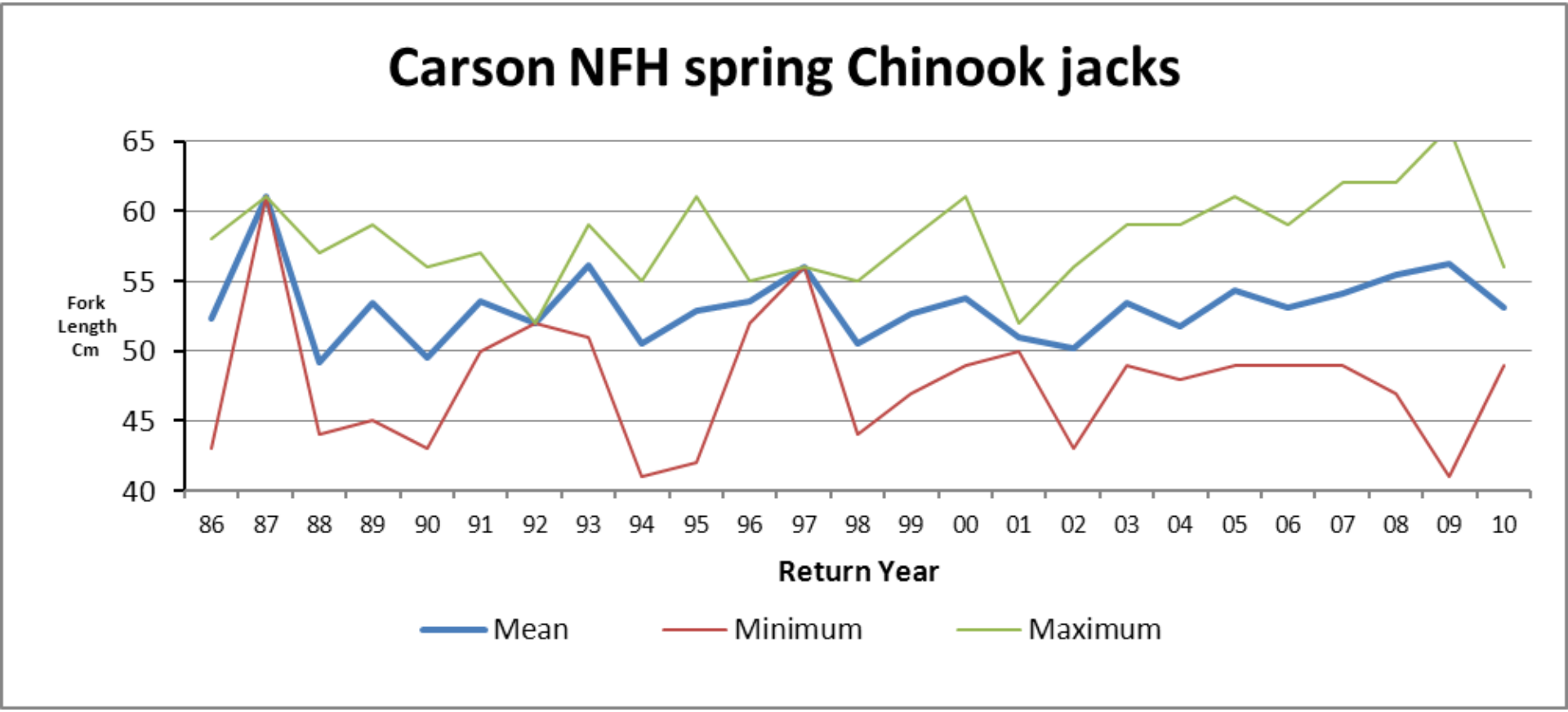
Chuck Fuller
David Hand
Chuck Hamstreet
Doug Olson
Steve Pastor

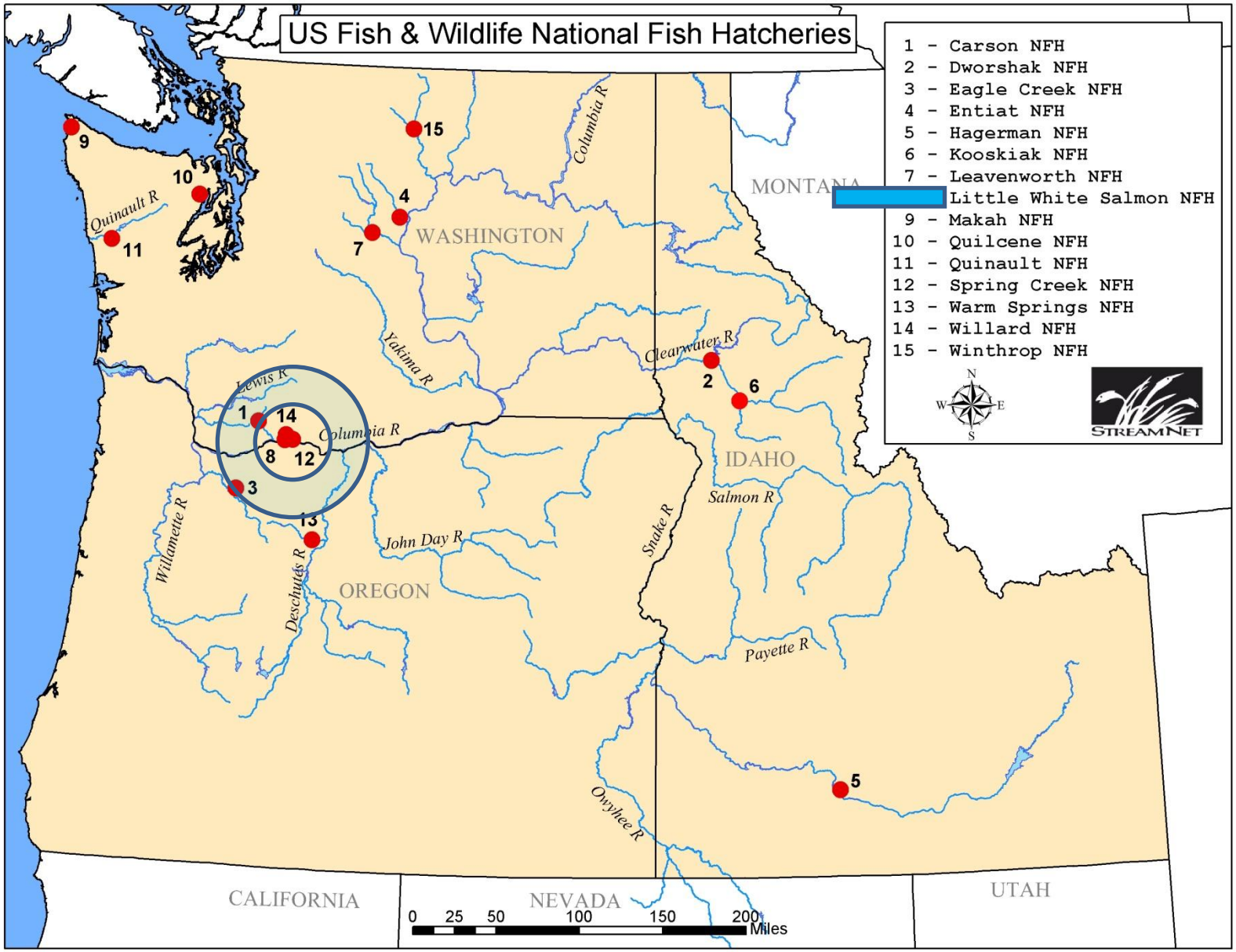

US Fish & Wildlife National Fish Hatcheries
1 - Carson NFH
2 - Dworshak NFH
3 - Eagle Creek NFH
4 - Entiat NFH
5 - Hagerman NFH
6 - Kooskiak NFH
7 - Leavenworth NFH
8 - Little White Salmon NFH
9 - Makah NFH
10 - Quilcene NFH
11 - Quinault NFH
12 - Spring Creek NFH
13 - Warm Springs NFH
14 - Willard NFH
15 - Winthrop NFH
MONTANA
WASHINGTON
OREGON
IDAHO
CALIFORNIA
NEVADA
Columbia R
Quinault R
Lewis R
Yakima R
Clearwater R
Columbia R
Willamette R
John Day R
Snake R
Owyhee R
Salmon R
0 25 50 100 150 200
N
W
E
S
STREAMNET
It's about cooperation
8 hatcheries

Size of Jacks by Return Year

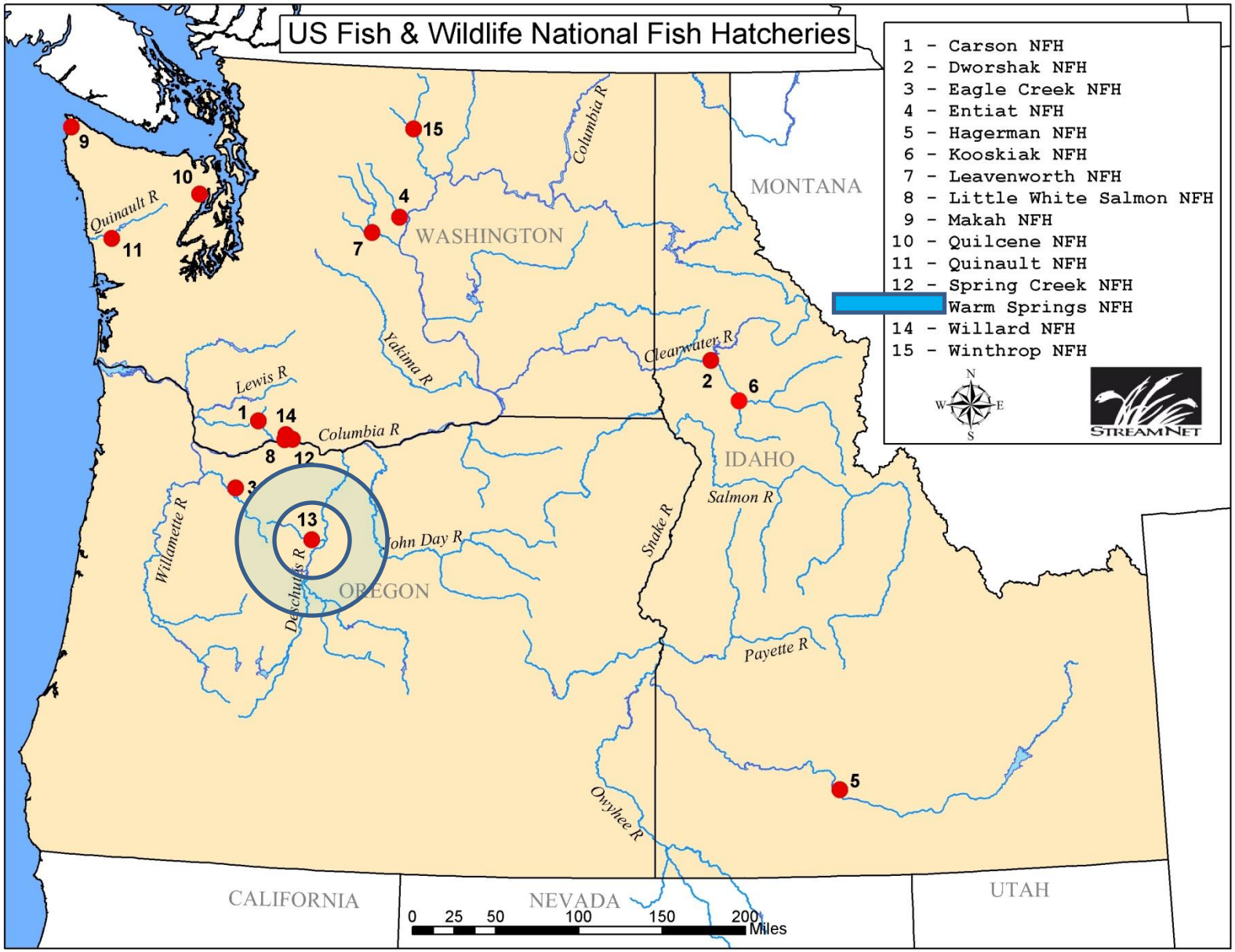
Will look at linear regression after slides.

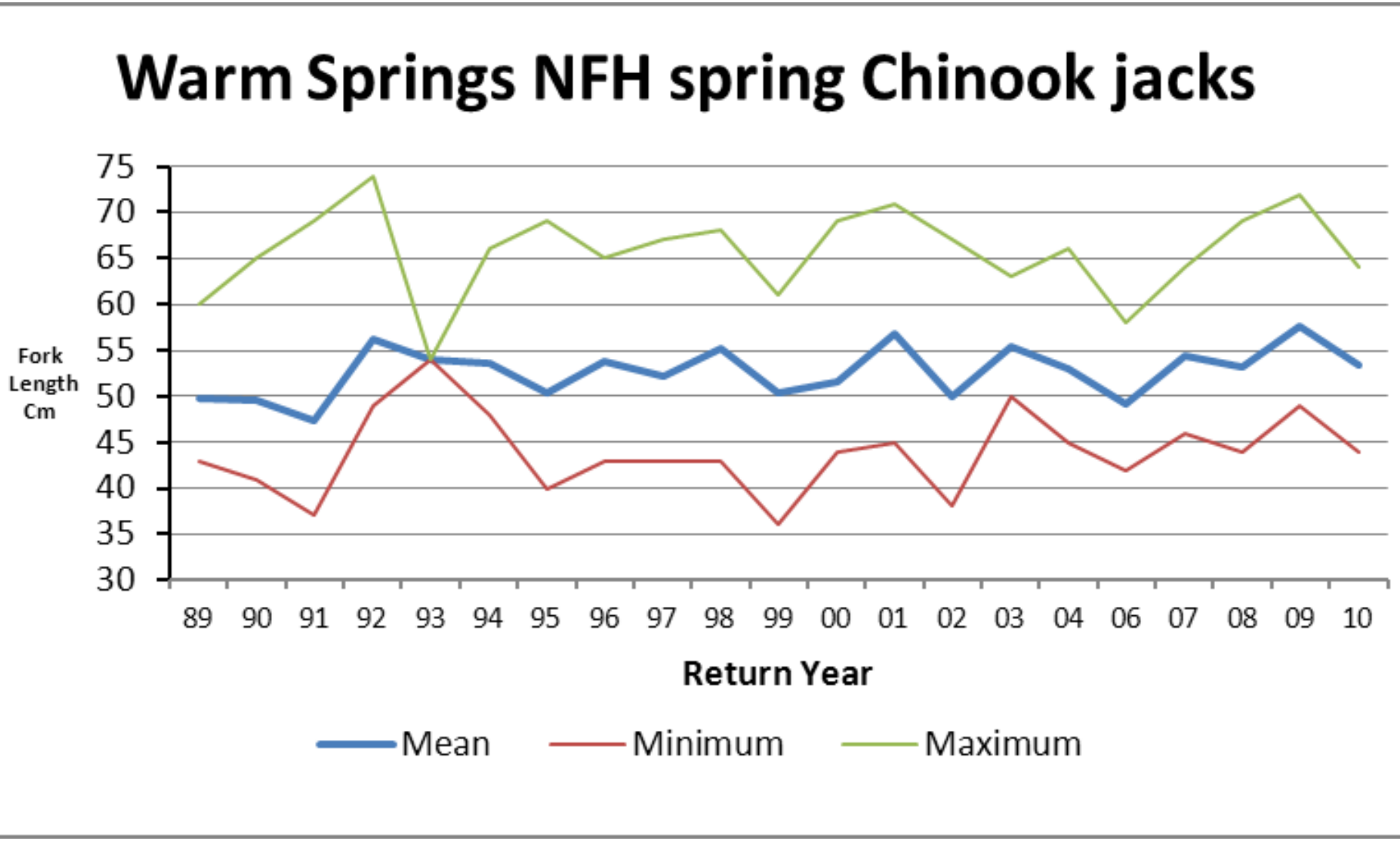

US Fish & Wildlife National Fish Hatcheries
1 - Carson NFH
2 - Dworshak NFH
3 - Eagle Creek NFH
4 - Entiat NFH
5 - Hagerman NFH
6 - Kooskiak NFH
7 - Leavenworth NFH
8 - Little White Salmon NFH
9 - Makah NFH
10 - Quilcene NFH
11 - Quinault NFH
12 - Spring Creek NFH
13 - Warm Springs NFH
14 - Willard NFH
15 - Winthrop NFH
N
W
E
S
StreamNet
WASHINGTON
OREGON
IDAHO
MONTANA
CALIFORNIA
NEVADA
UTAH
Columbia R
Quinault R
Yakima R
Lewis R
Columbia R
Clearwater R
Salmon R
Snake R
John Day R
Willamette R
Deschutes R
Payette R
Owyhee R
0 25 50 100 150 200
Miles

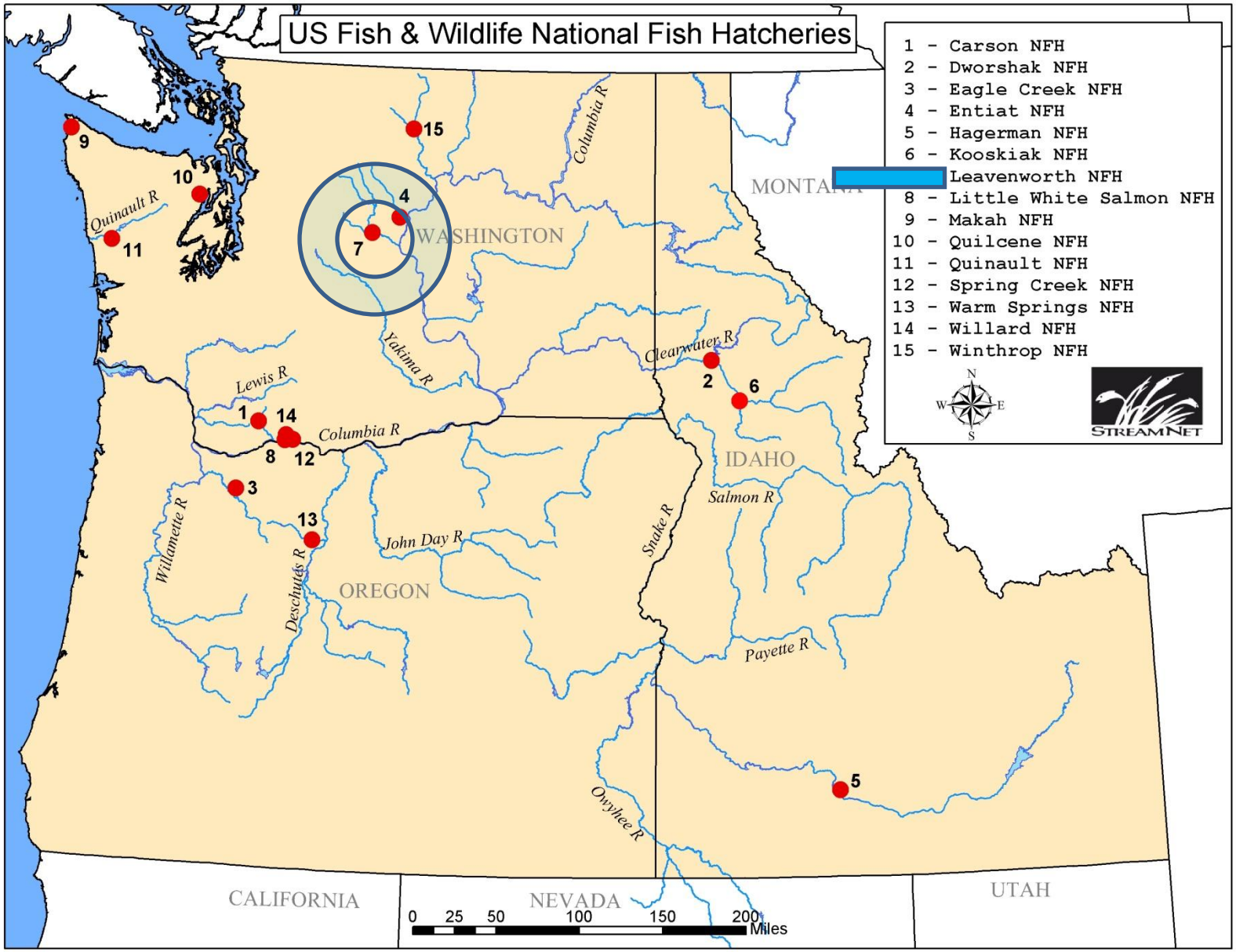

Carson NFH spring Chinook jacks
Fork Length Cm
65
60
55
50
45
40
86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Return Year
Mean
Minimum
Maximum

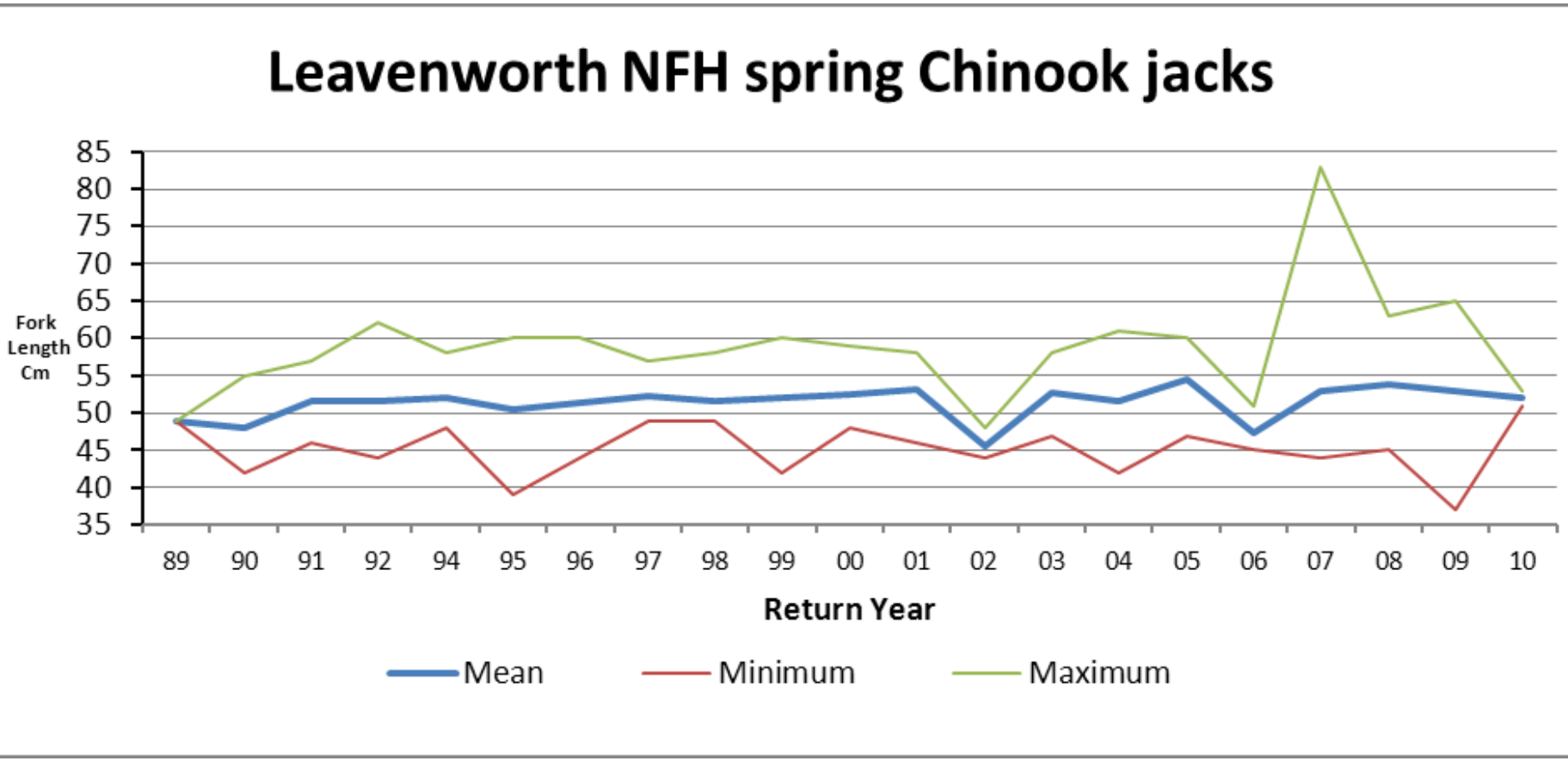

US Fish & Wildlife National Fish Hatcheries
1 - Carson NFH
2 - Dworshak NFH
3 - Eagle Creek NFH
4 - Entiat NFH
5 - Hagerman NFH
6 - Kooskiak NFH
7 - Leavenworth NFH
8 - Little White Salmon NFH
9 - Makah NFH
10 - Quilcene NFH
11 - Quinault NFH
12 - Spring Creek NFH
13 - Warm Springs NFH
14 - Willard NFH
15 - Winthrop NFH
N
W
E
S
StreamNet
WASHINGTON
OREGON
IDAHO
MONTANA
CALIFORNIA
NEVADA
UTAH
Columbia R
Quinault R
Yakima R
Lewis R
Clearwater R
Salmon R
Snake R
John Day R
Willamette R
Deschutes R
Payette R
Owyhee R
0 25 50 100 150 200 Miles

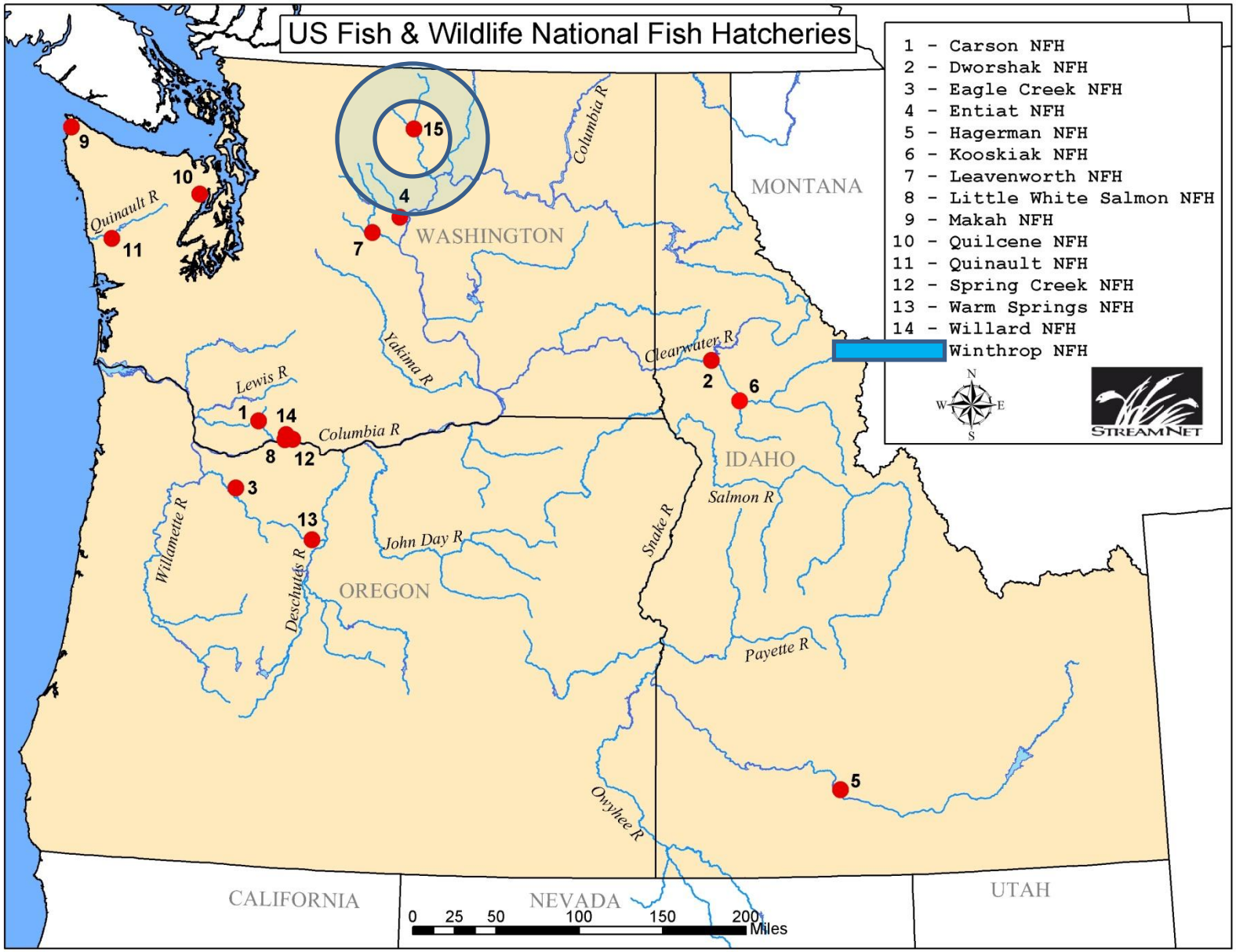
Little White Salmon NFH spring Chinook jacks


US Fish & Wildlife National Fish Hatcheries
1 - Carson NFH
2 - Dworshak NFH
3 - Eagle Creek NFH
4 - Entiat NFH
5 - Hagerman NFH
6 - Kooskiak NFH
7 - Leavenworth NFH
8 - Little White Salmon NFH
9 - Makah NFH
10 - Quilcene NFH
11 - Quinault NFH
12 - Spring Creek NFH
13 - Warm Springs NFH
14 - Willard NFH
15 - Winthrop NFH
N
W
E
S
StreamNet
WASHINGTON
OREGON
IDAHO
MONTANA
CALIFORNIA
NEVADA
UTAH
Columbia R
Quinault R
Lewis R
Yakima R
Clearwater R
Columbia R
Willamette R
Deschutes R
John Day R
Snake R
Salmon R
Payette R
Owyhee R
0 25 50 100 150 200 Miles

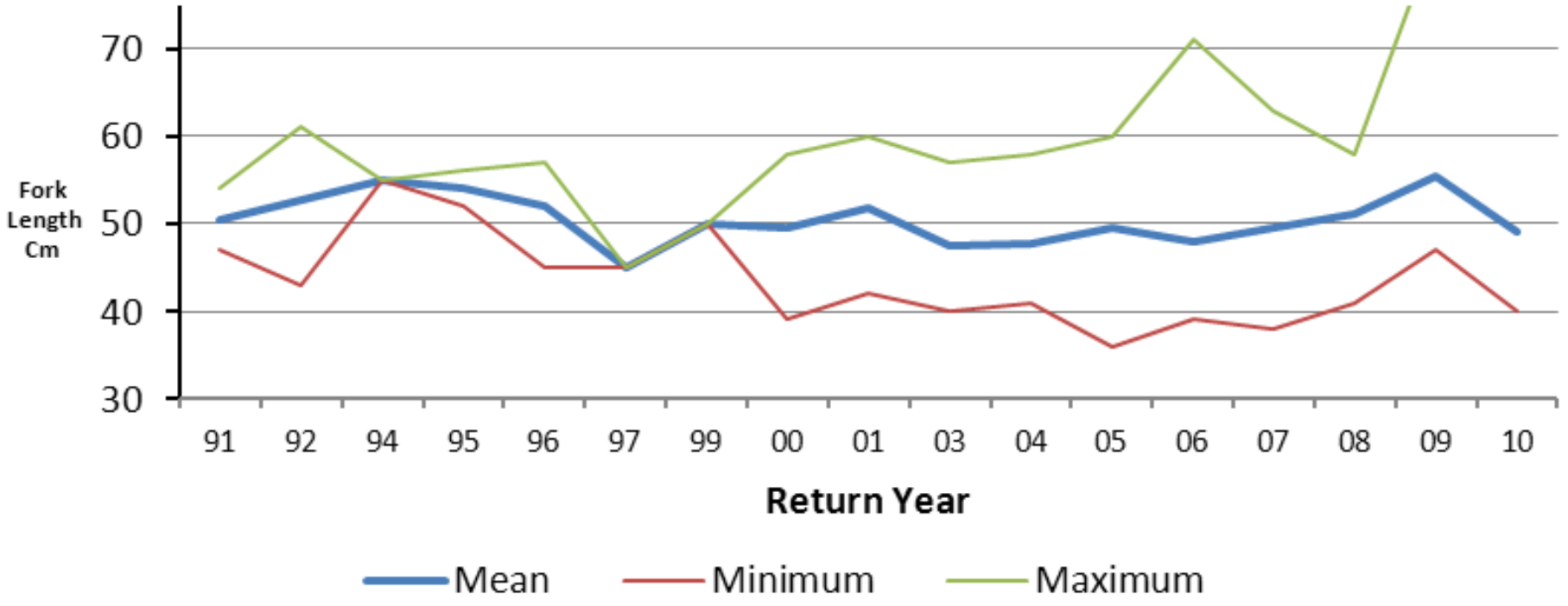

Warm Springs NFH spring Chinook jacks
Fork Length Cm
75
70
65
60
55
50
45
40
35
30
89
90
91
92
93
94
95
96
97
98
99
00
01
02
03
04
06
07
08
09
10
Return Year
Mean
Minimum
Maximum


US Fish & Wildlife National Fish Hatcheries
1 - Carson NFH
2 - Dworshak NFH
3 - Eagle Creek NFH
4 - Entiat NFH
5 - Hagerman NFH
6 - Kooskiak NFH
7 - Leavenworth NFH
8 - Little White Salmon NFH
9 - Makah NFH
10 - Quilcene NFH
11 - Quinault NFH
12 - Spring Creek NFH
13 - Warm Springs NFH
14 - Willard NFH
15 - Winthrop NFH
N
W
E
S
StreamNet
WASHINGTON
OREGON
IDAHO
MONTANA
CALIFORNIA
NEVADA
UTAH
Columbia R
Quinault R
Lewis R
Yakima R
Clearwater R
Columbia R
Willamette R
Deschutes R
John Day R
Snake R
Salmon R
Payette R
Owyhee R
0 25 50 100 150 200 Miles


Leavenworth NFH spring Chinook jacks
Fork Length Cm
85
80
75
70
65
60
55
50
45
40
35
89
90
91
92
94
95
96
97
98
99
00
01
02
03
04
05
06
07
08
09
10
Return Year
Mean
Minimum
Maximum


US Fish & Wildlife National Fish Hatcheries
1 - Carson NFH
2 - Dworshak NFH
3 - Eagle Creek NFH
4 - Entiat NFH
5 - Hagerman NFH
6 - Kooskiak NFH
7 - Leavenworth NFH
8 - Little White Salmon NFH
9 - Makah NFH
10 - Quilcene NFH
11 - Quinault NFH
12 - Spring Creek NFH
13 - Warm Springs NFH
14 - Willard NFH
Winthrop NFH
N
W
E
S
StreamNet
WASHINGTON
OREGON
IDAHO
MONTANA
CALIFORNIA
NEVADA
UTAH
Columbia R
Quinault R
Lewis R
Yakima R
Clearwater R
Columbia R
Willamette R
Deschutes R
John Day R
Snake R
Salmon R
Payette R
Owyhee R
0 25 50 100 150 200
Miles

Winthrop NFH spring Chinook jacks

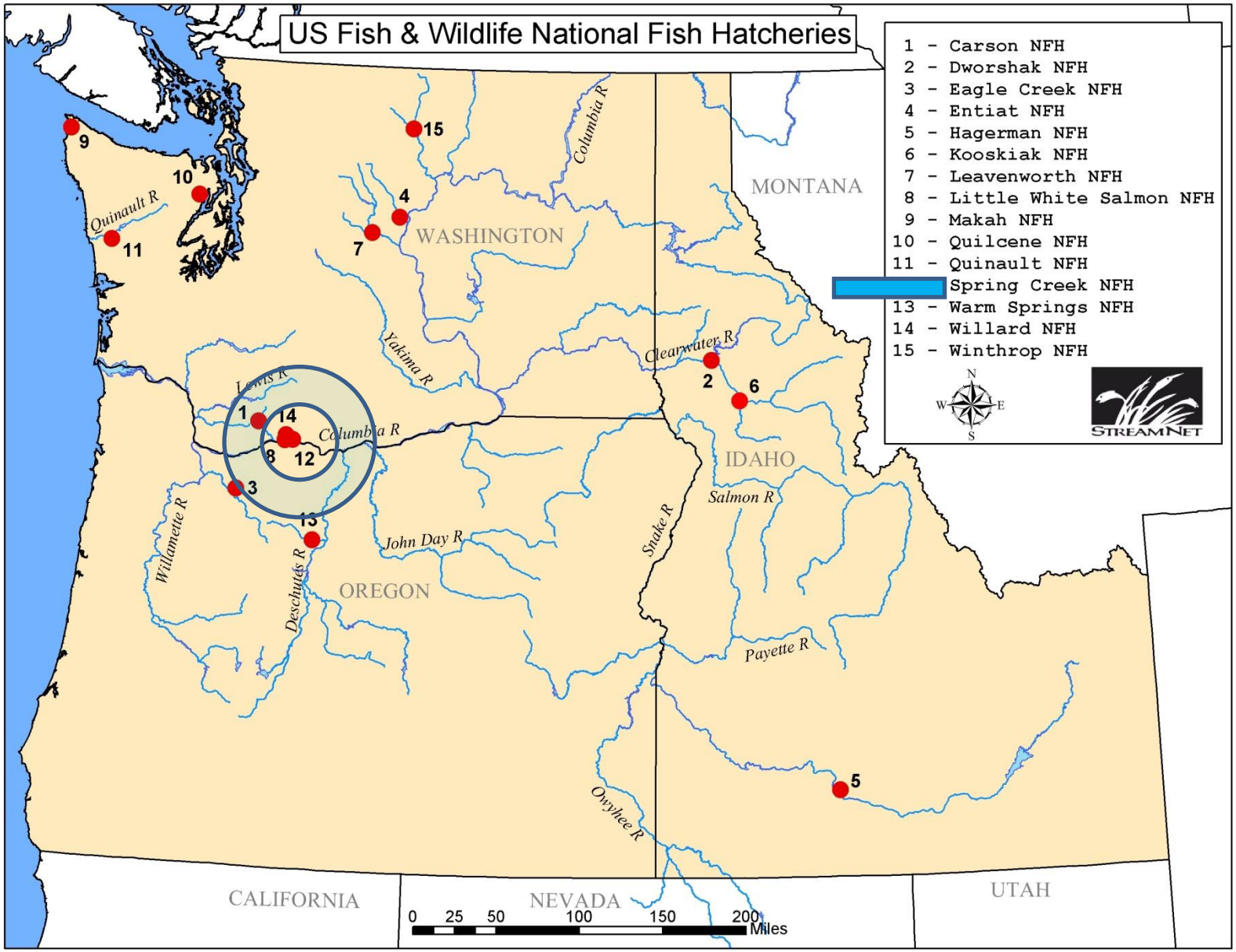


spring Chinook

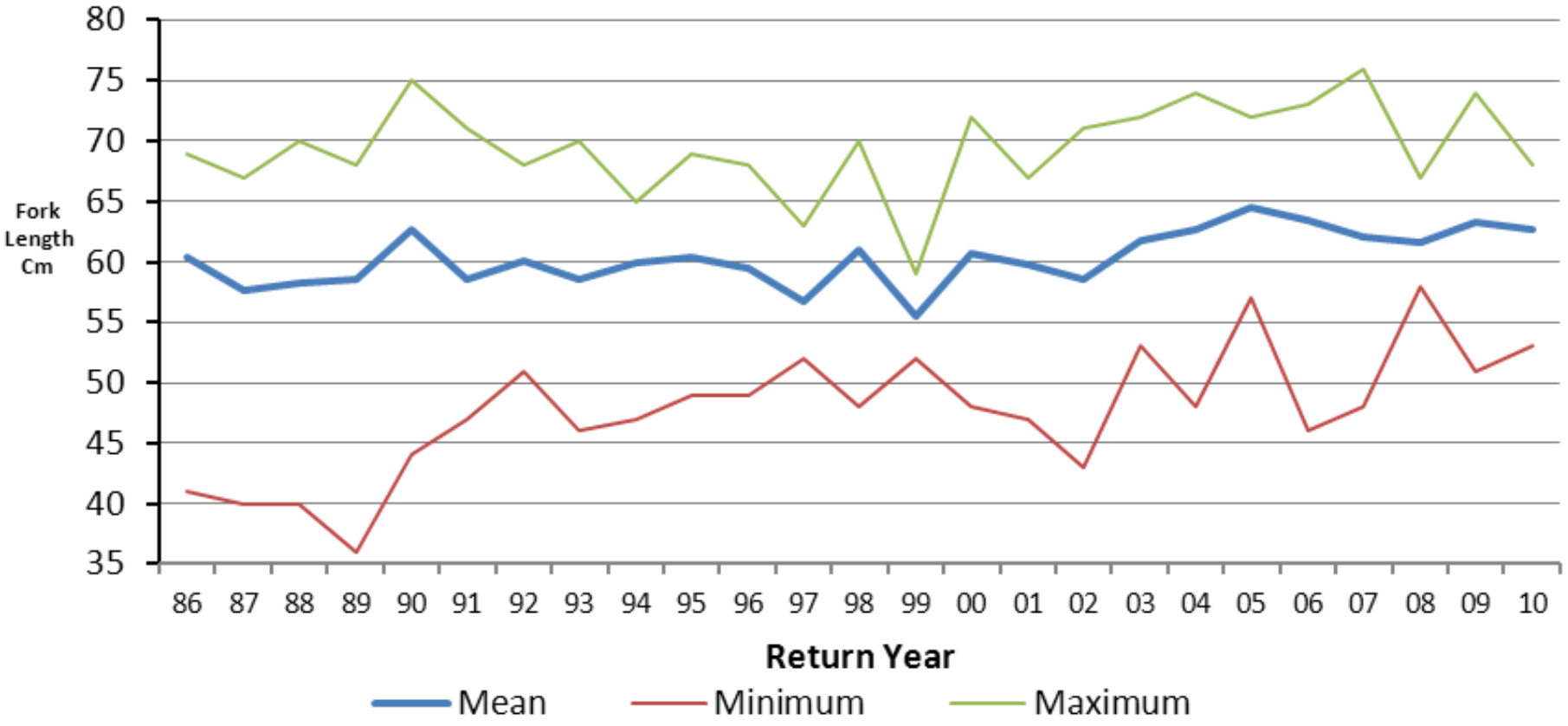
Length of Jacks as a function of Return Year

Carson	y = -0.03 x + 55.88	r = -0.09	r squared = 0.0187
Little White	y = -0.06 x + 58.97	r = -0.18	r squared = 0.03
Warm Springs	y = 0.18 x + 34.46	r = 0.42	r squared = 0.18
Leavenworth	y = 0.03 x + 55.88	r = 0.09	r squared = 0.01
Winthrop	y = -0.00 x + 60.54	r = -0.22	r squared = 0.0575

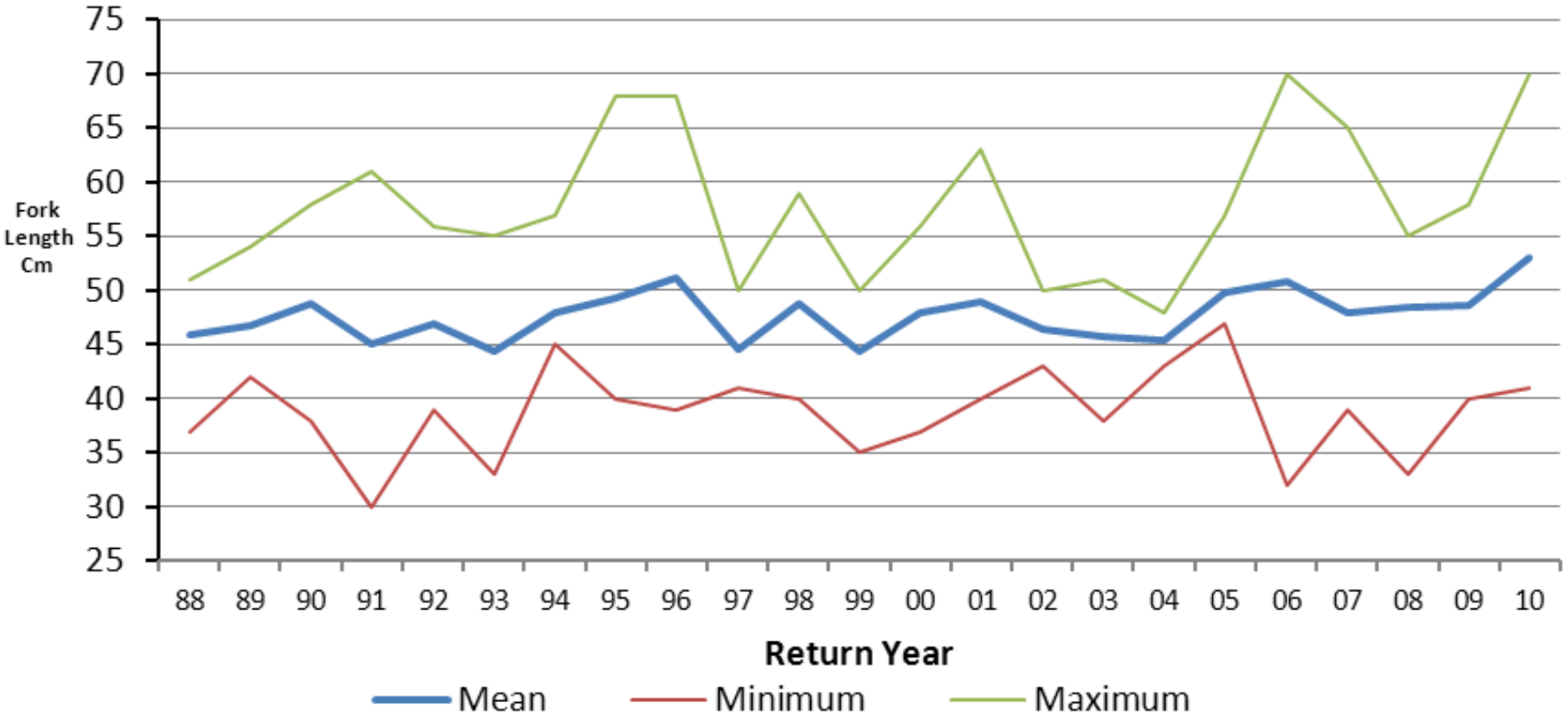
A correlation greater than 0.8 is generally described as strong, whereas a correlation less than 0.5 is generally described as weak.


US Fish & Wildlife National Fish Hatcheries
1 - Carson NFH
2 - Dworshak NFH
3 - Eagle Creek NFH
4 - Entiat NFH
5 - Hagerman NFH
6 - Kooskiak NFH
7 - Leavenworth NFH
8 - Little White Salmon NFH
9 - Makah NFH
10 - Quilcene NFH
11 - Quinault NFH
12 - Spring Creek NFH
13 - Warm Springs NFH
14 - Willard NFH
15 - Winthrop NFH
N
W
E
S
StreamNet
WASHINGTON
OREGON
IDAHO
MONTANA
CALIFORNIA
NEVADA
UTAH
Columbia R
Quinault R
Yakima R
Lewis R
Columbia R
Clearwater R
Salmon R
Snake R
Willamette R
Deschutes R
John Day R
Payette R
Owyhee R
0 25 50 100 150 200 Miles

Spring Creek NFH
Tule fall chinook jacks



Little White Salmon NFH
upriver bright fall chinook jacks



fall Chinook

Length of Jacks as a function of Return Year

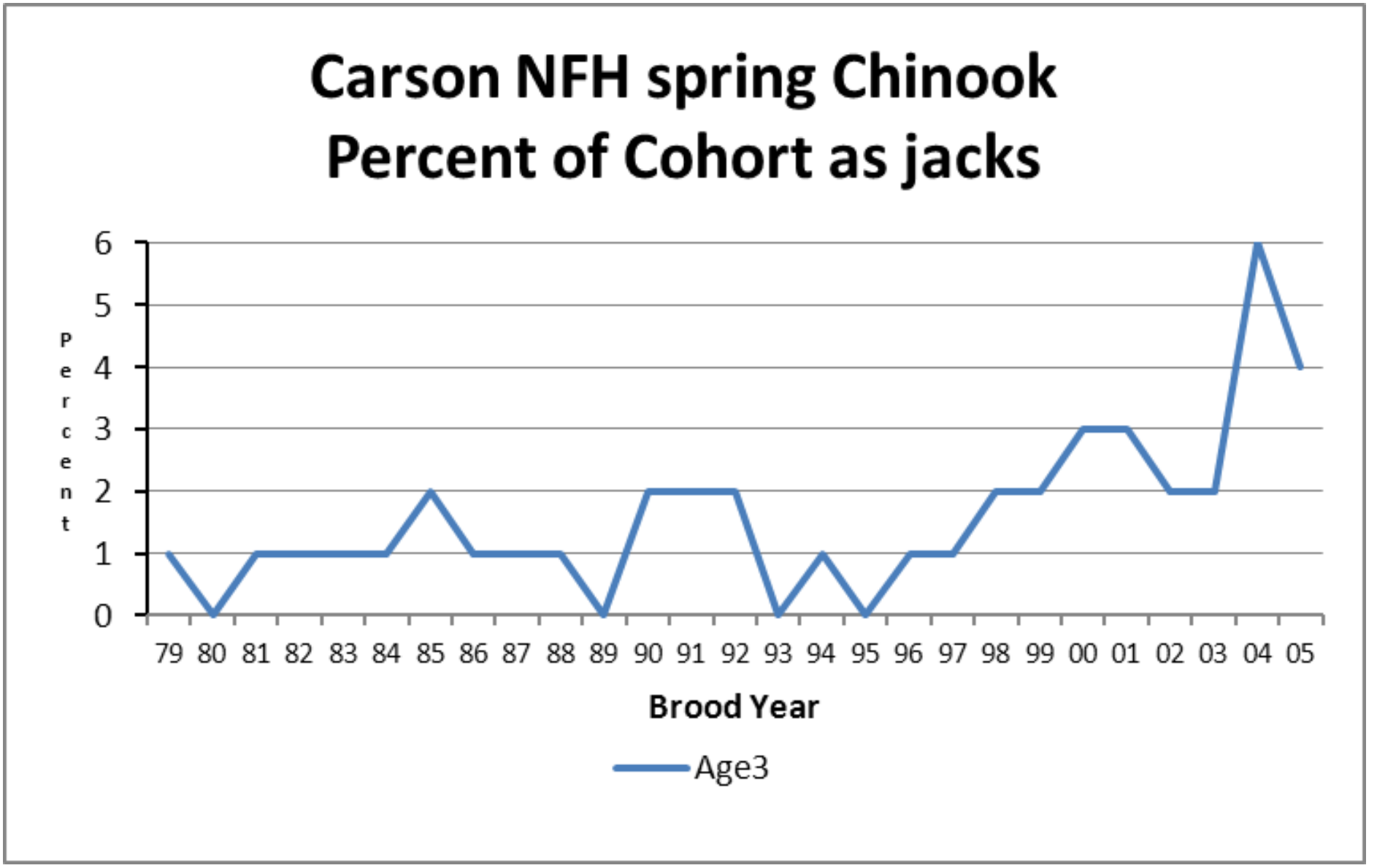
Little White y = 0.11 x + 36.73 r = 0.36 r squared = 0.13

Spring Creek y = 0.13 x + 47.50 r = 0.50 r squared = 0.25

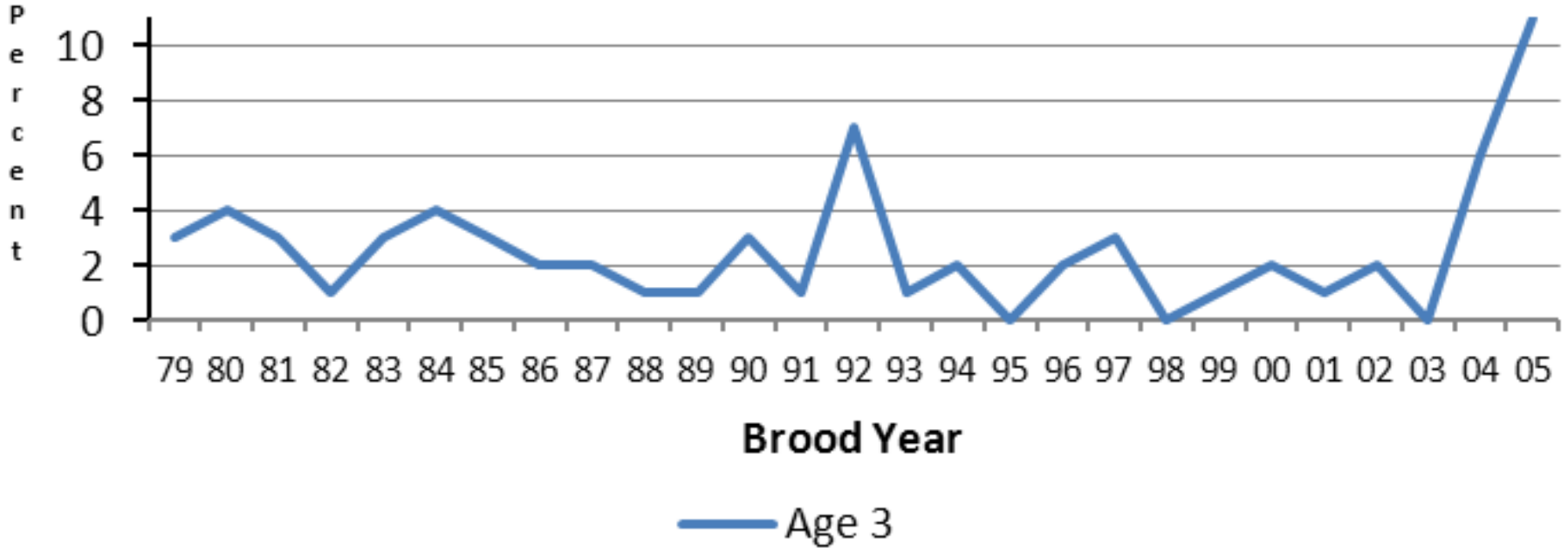
~ 1.2 cm per decade

Percent of each Brood Year returning as Jacks

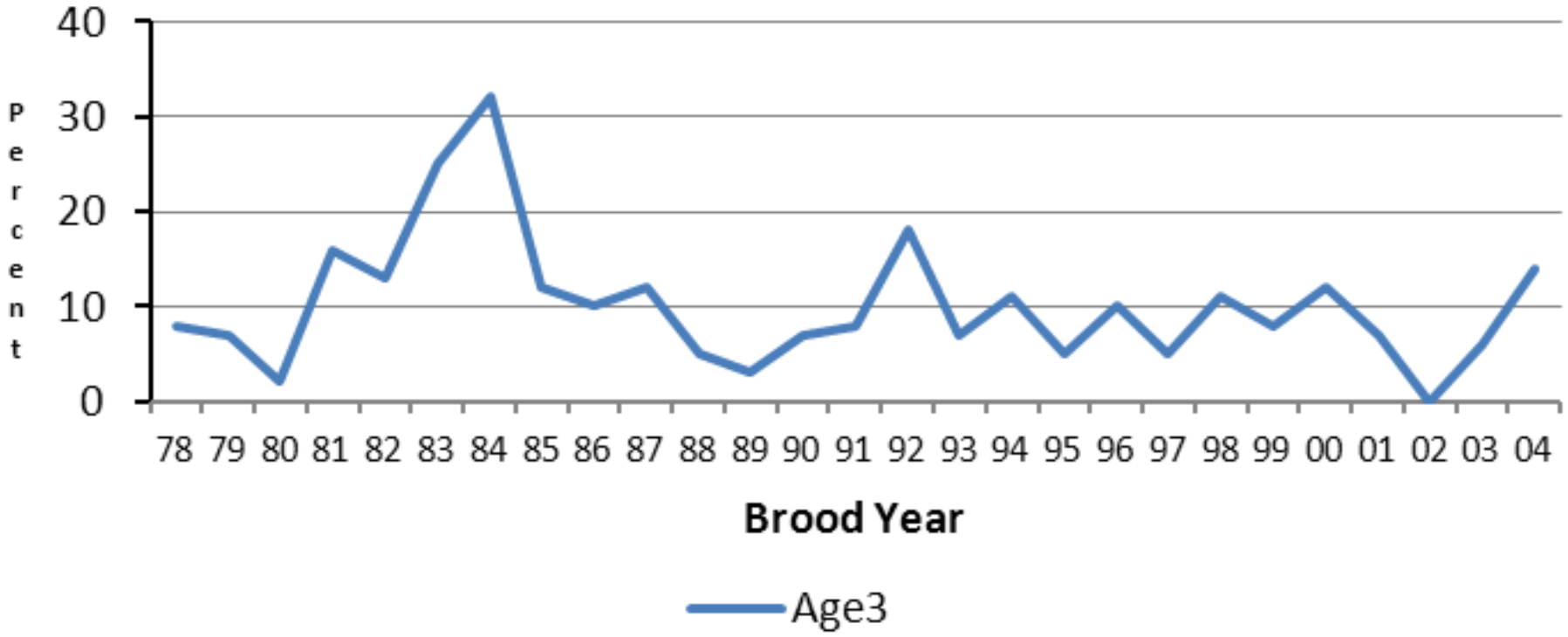
- Assemble a Cohort for each Brood Year, and determine percent returning at each age


Carson NFH spring Chinook
Percent of Cohort as jacks
Percent
0
1
2
3
4
5
6
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
Brood Year
Age3

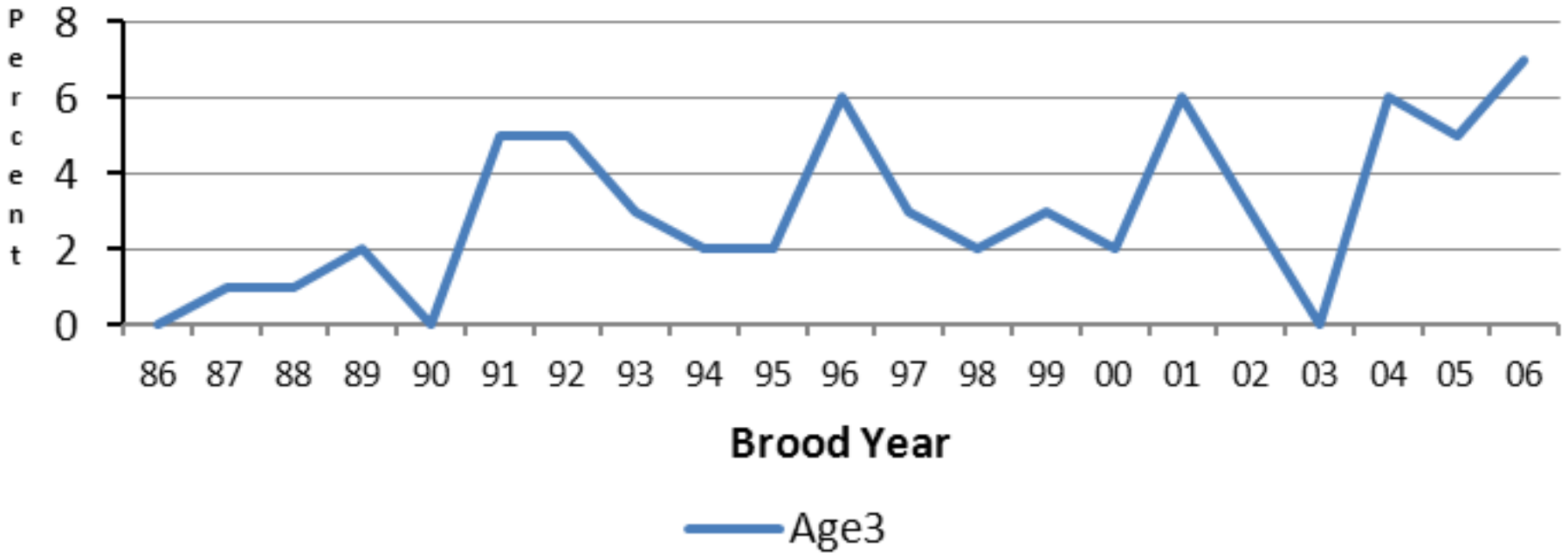
Little White Salmon NFH
spring Chinook
Percent of Cohort as jacks

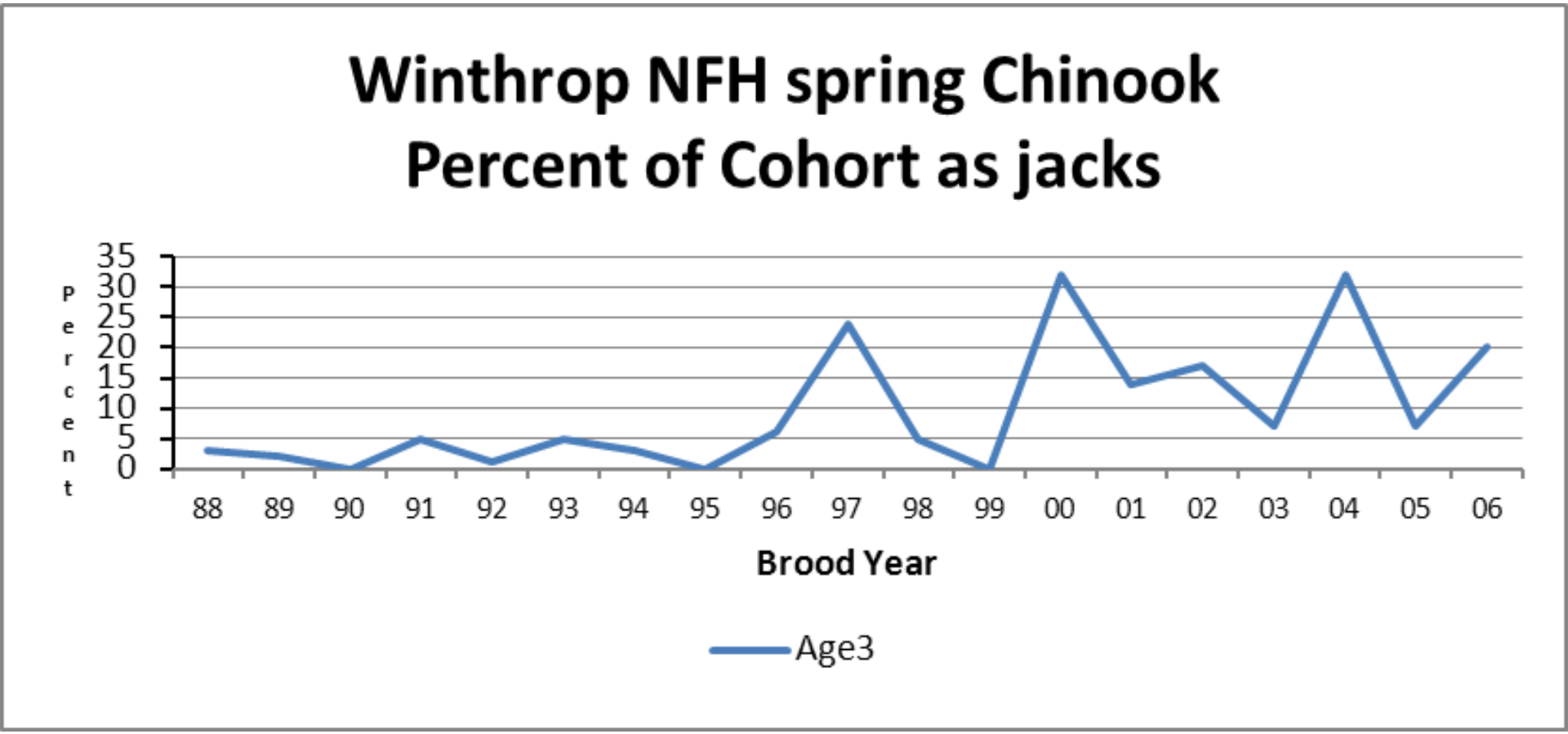


Warm Springs NFH spring Chinook
Percent of Cohort as jacks



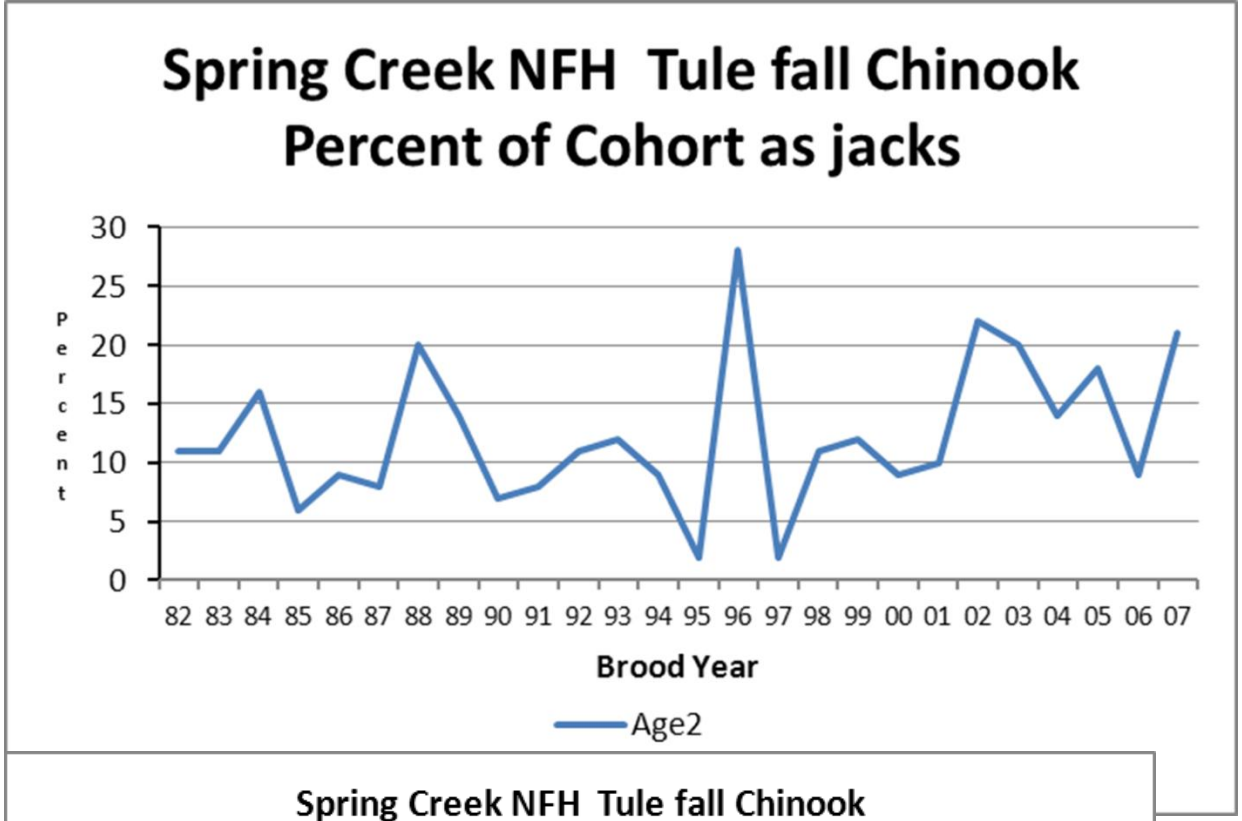
Leavenworth NFH
spring Chinook
Percent of Cohort as jacks

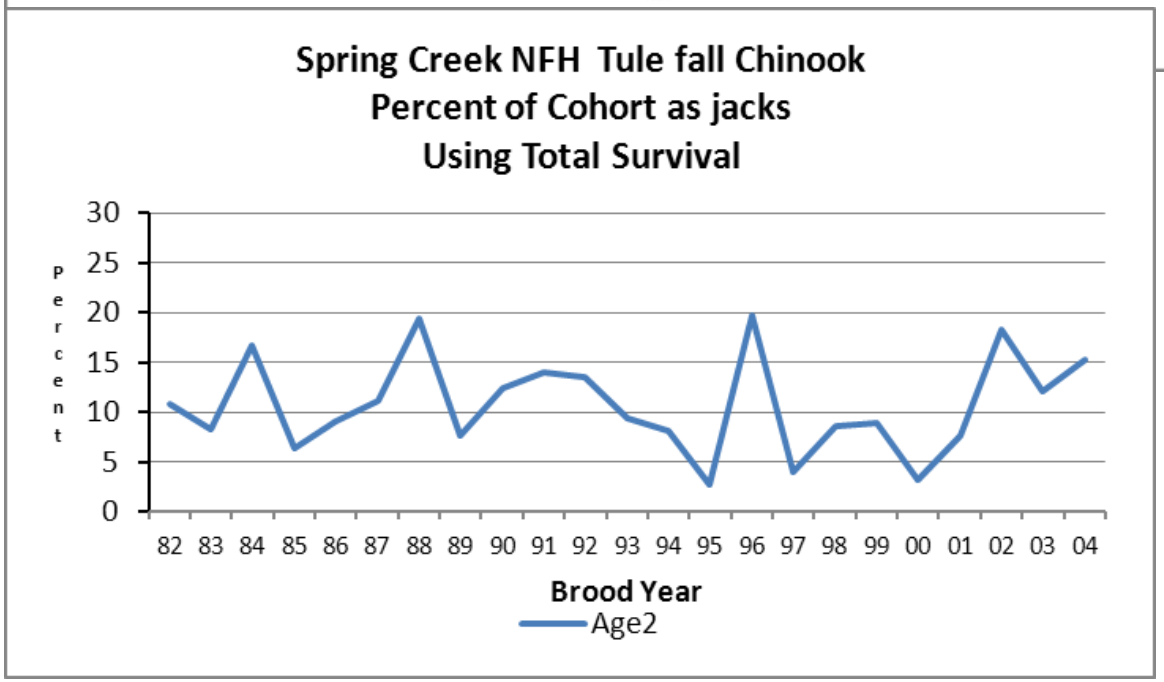



Winthrop NFH spring Chinook
Percent of Cohort as jacks
Percent
35
30
25
20
15
10
5
0
88
89
90
91
92
93
94
95
96
97
98
99
00
01
02
03
04
05
06
Brood Year
Age3

Percent Returning as Jacks as a function of Brood Year

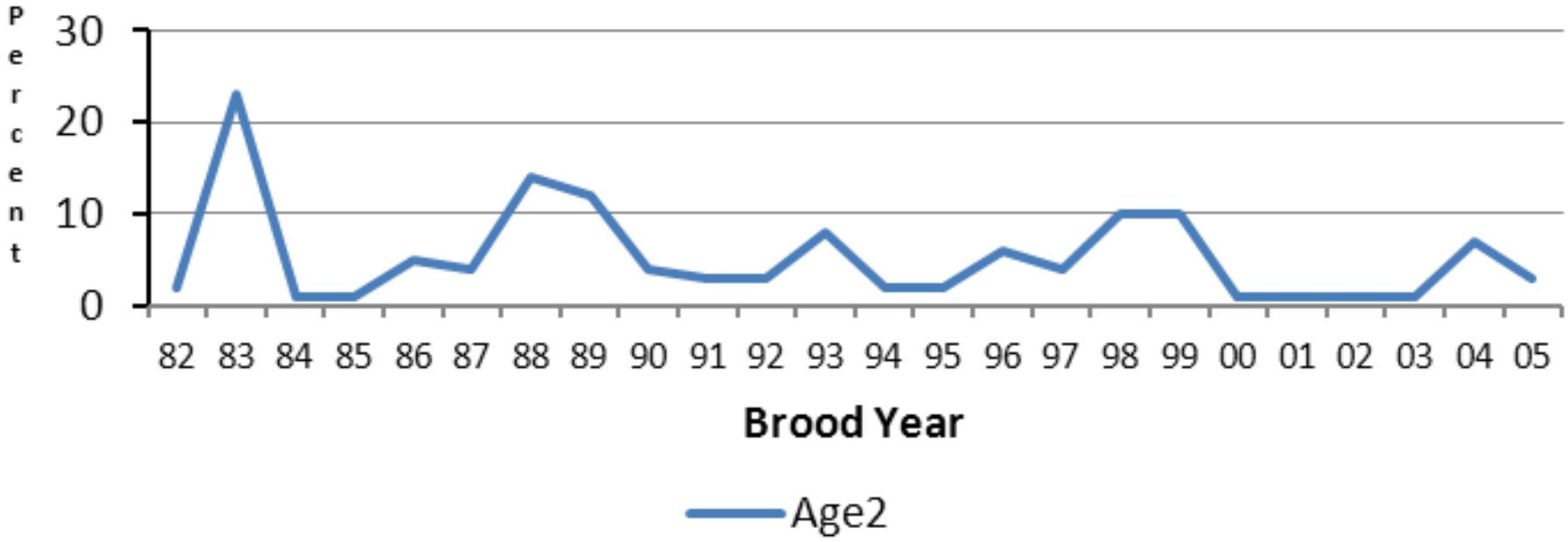
Carson	y = 0.15 x + --11.71	r = 0.64	r squared = 0.4045
Little White	y = -0.08 x + 9.09	r = -0.36	r squared = 0.1363
Warm Springs	y = -0.25 x + 32.54	r = -0.27	r squared = 0.0739
Leavenworth	y = 0.19 x + --14.91	r = 0.53	r squared = 0.2846
Winthrop	y = 1.08 x + --95.03	r = 0.57	r squared = 0.3226





Harvest Management inflated the percent of jacks of brood year 1996

Little White Salmon NFH upriver bright fall Chinook Percent of Cohort as jacks



fall Chinook

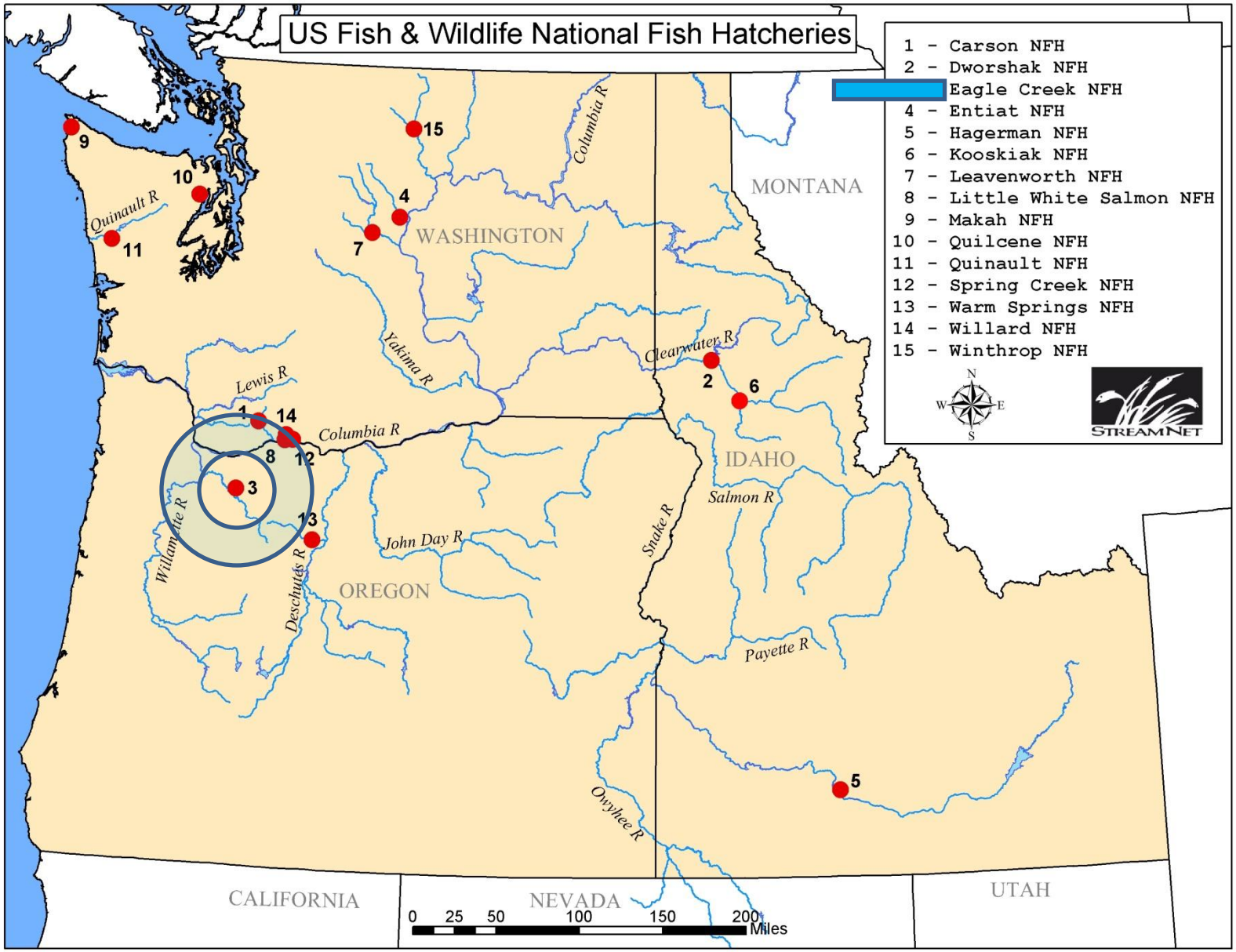
Percent Returning as Jacks as a function of Brood Year

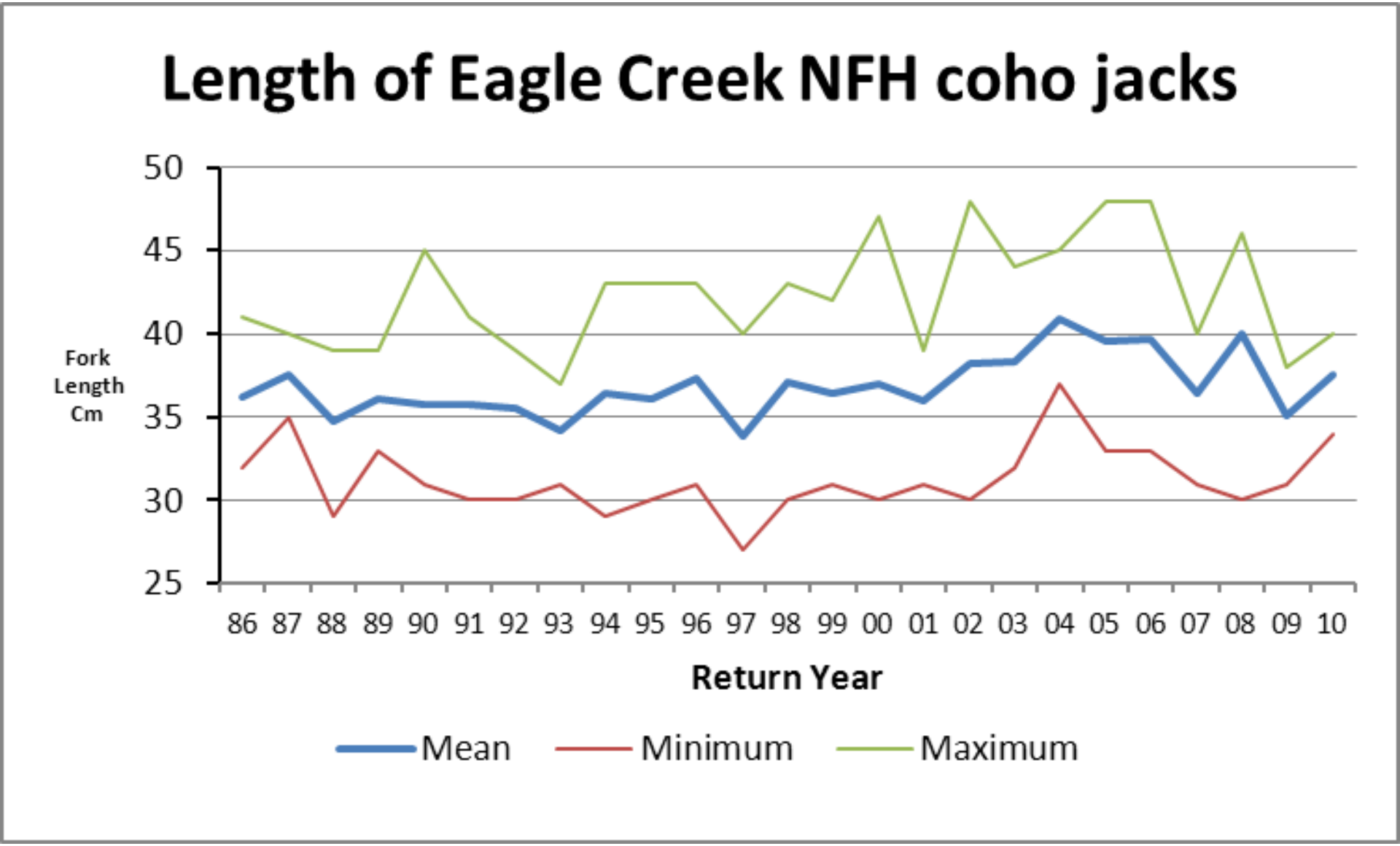
Little White y = 0.11 x + 36.73 r = 0.36 r squared = 0.13

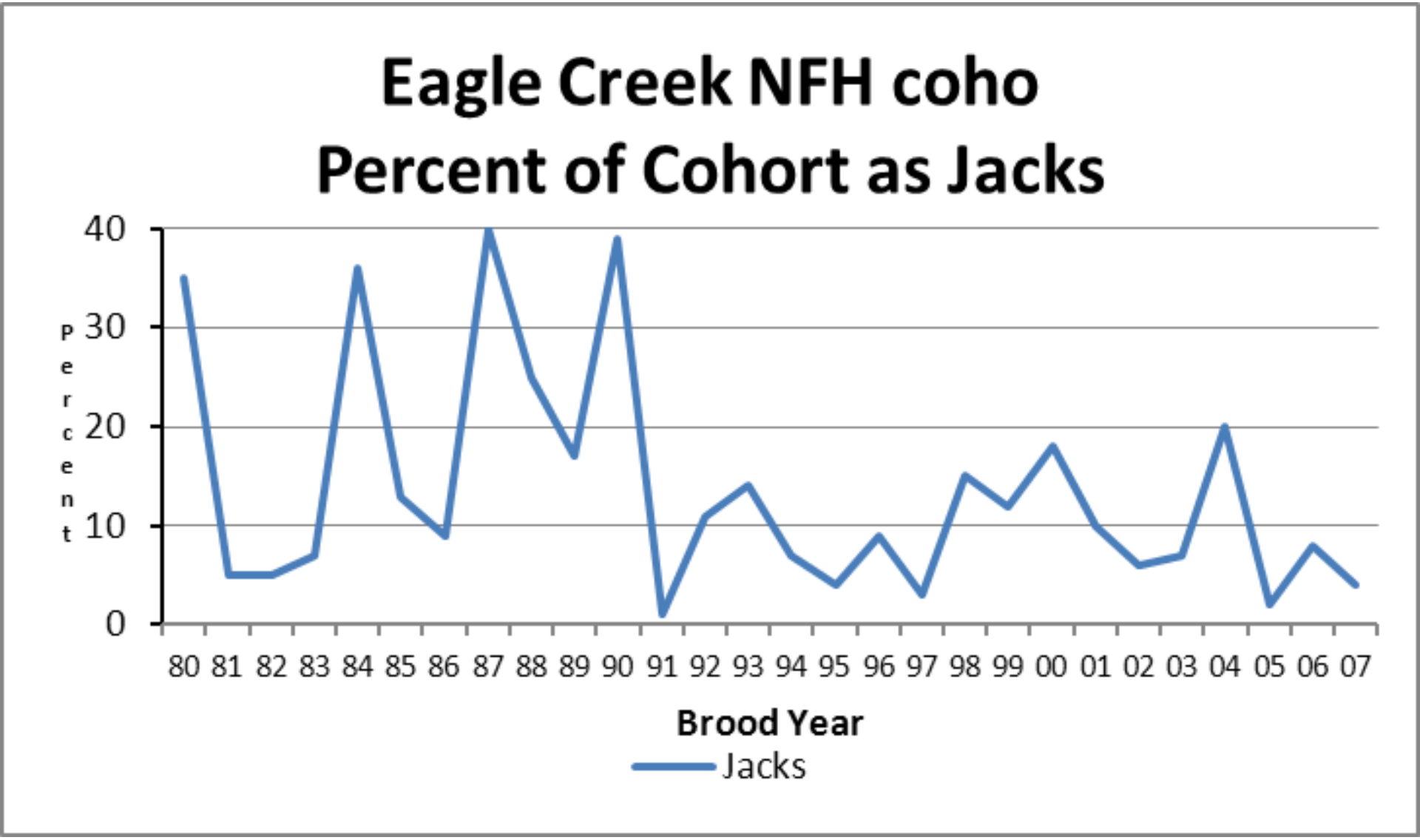
Spring Creek y = 0.13 x + 47.50 r = 0.50 r squared = 0.25

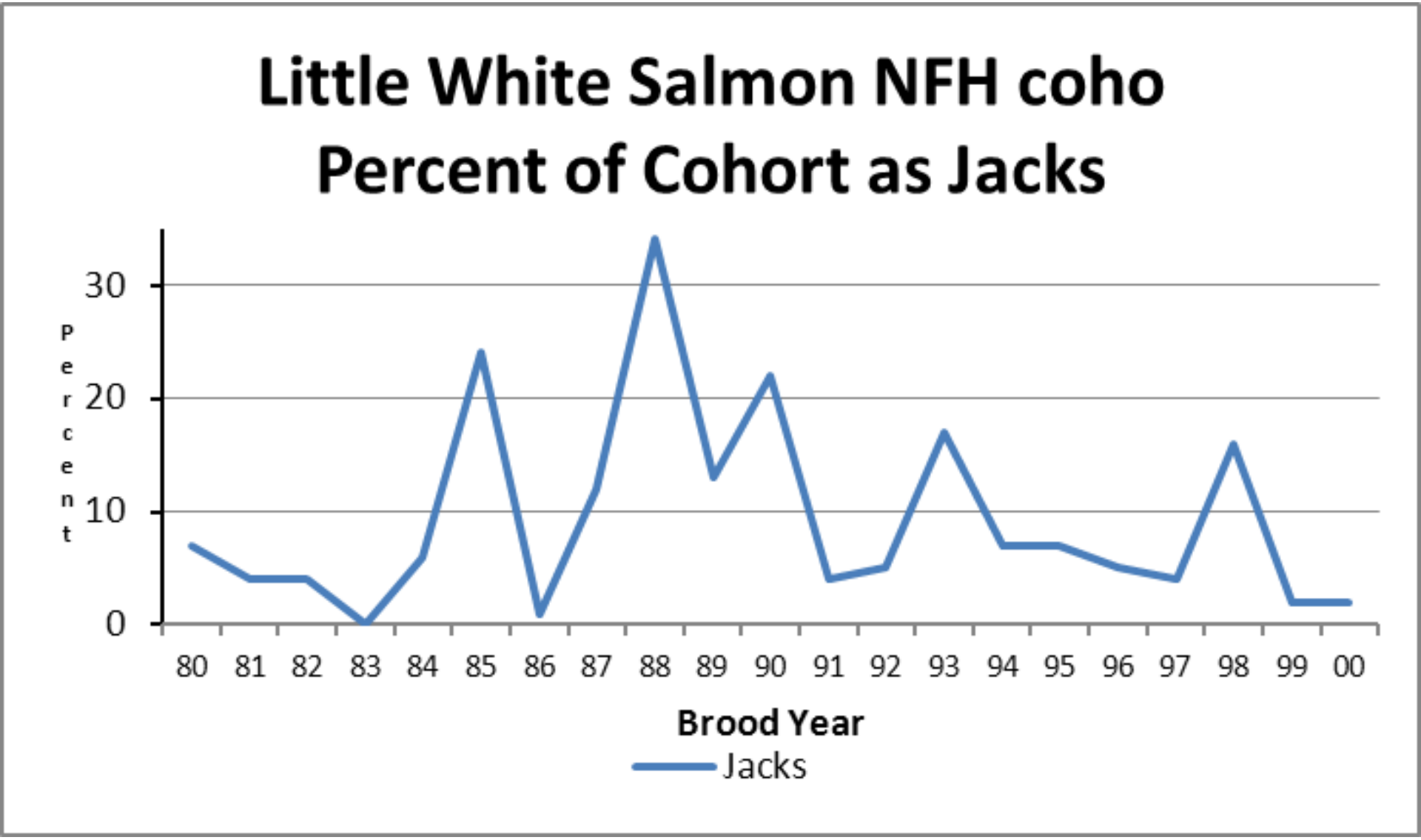
Coho and winter Steelhead:

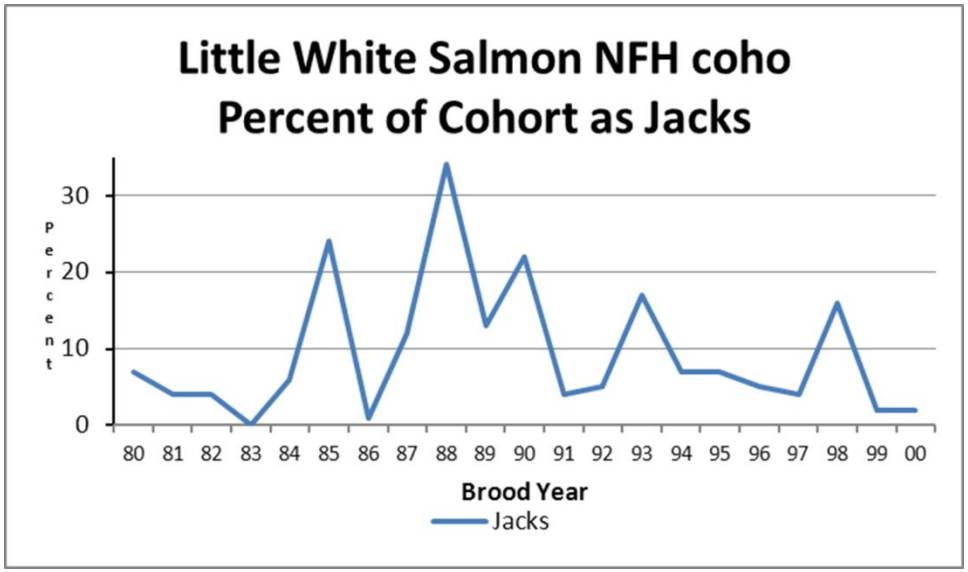
Length of “Jacks” and Percent Returning as “Jacks”

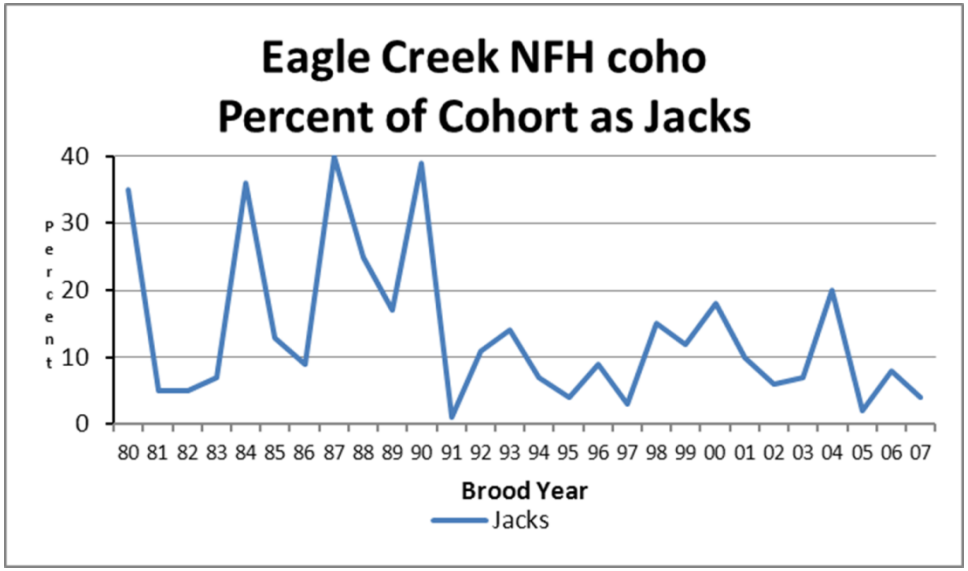

US Fish & Wildlife National Fish Hatcheries
1 - Carson NFH
2 - Dworshak NFH
Eagle Creek NFH
4 - Entiat NFH
5 - Hagerman NFH
6 - Kooskiak NFH
7 - Leavenworth NFH
8 - Little White Salmon NFH
9 - Makah NFH
10 - Quilcene NFH
11 - Quinault NFH
12 - Spring Creek NFH
13 - Warm Springs NFH
14 - Willard NFH
15 - Winthrop NFH
N
W
E
S
StreamNet
WASHINGTON
OREGON
IDAHO
MONTANA
CALIFORNIA
NEVADA
UTAH
Columbia R
Quinault R
Lewis R
Yakima R
Clearwater R
Columbia R
Willamette R
Deschutes R
John Day R
Snake R
Salmon R
Payette R
Owyhee R
0 25 50 100 150 200
Miles

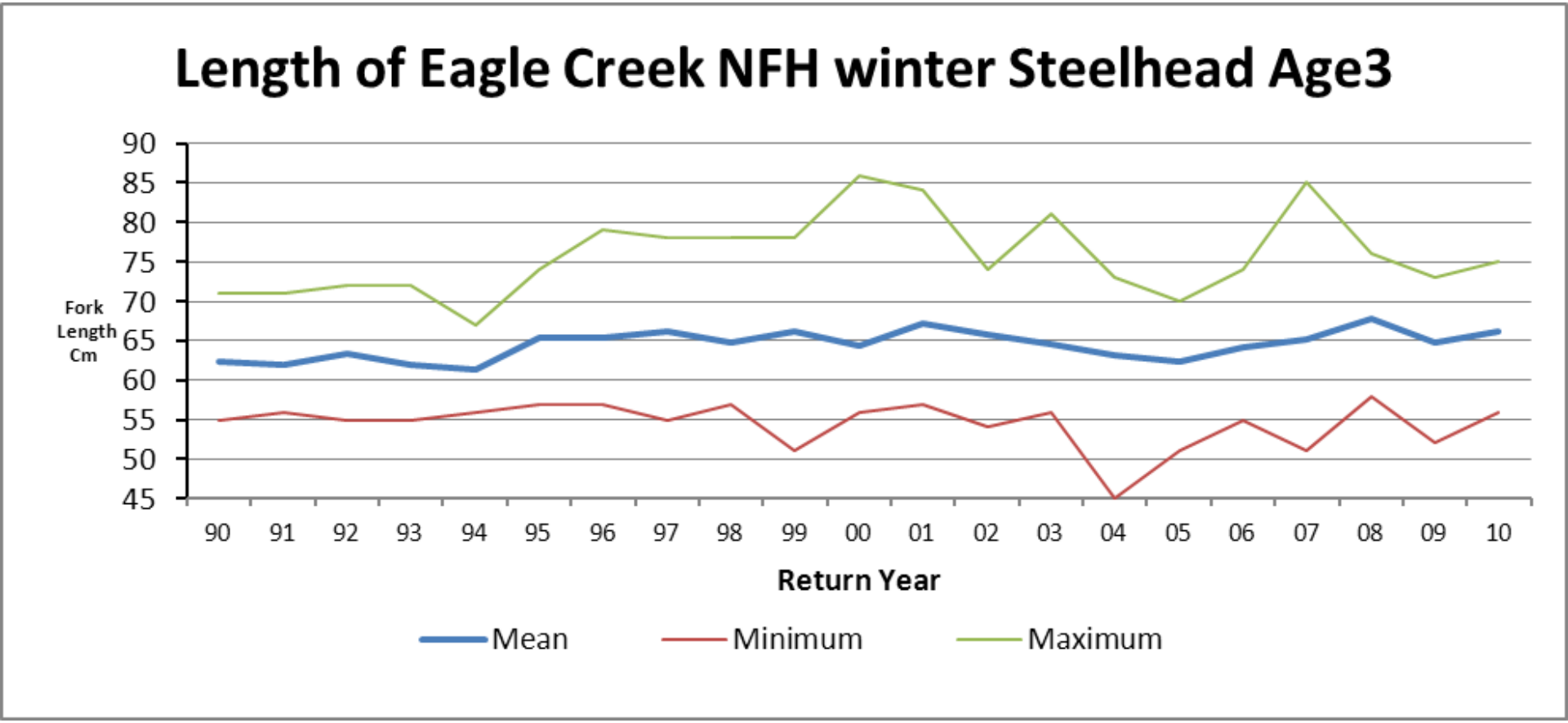

Length of Eagle Creek NFH coho jacks
Fork Length Cm
50
45
40
35
30
25
86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Return Year
Mean
Minimum
Maximum


Eagle Creek NFH coho
Percent of Cohort as Jacks
Percent
40
30
20
10
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07
Brood Year
Jacks

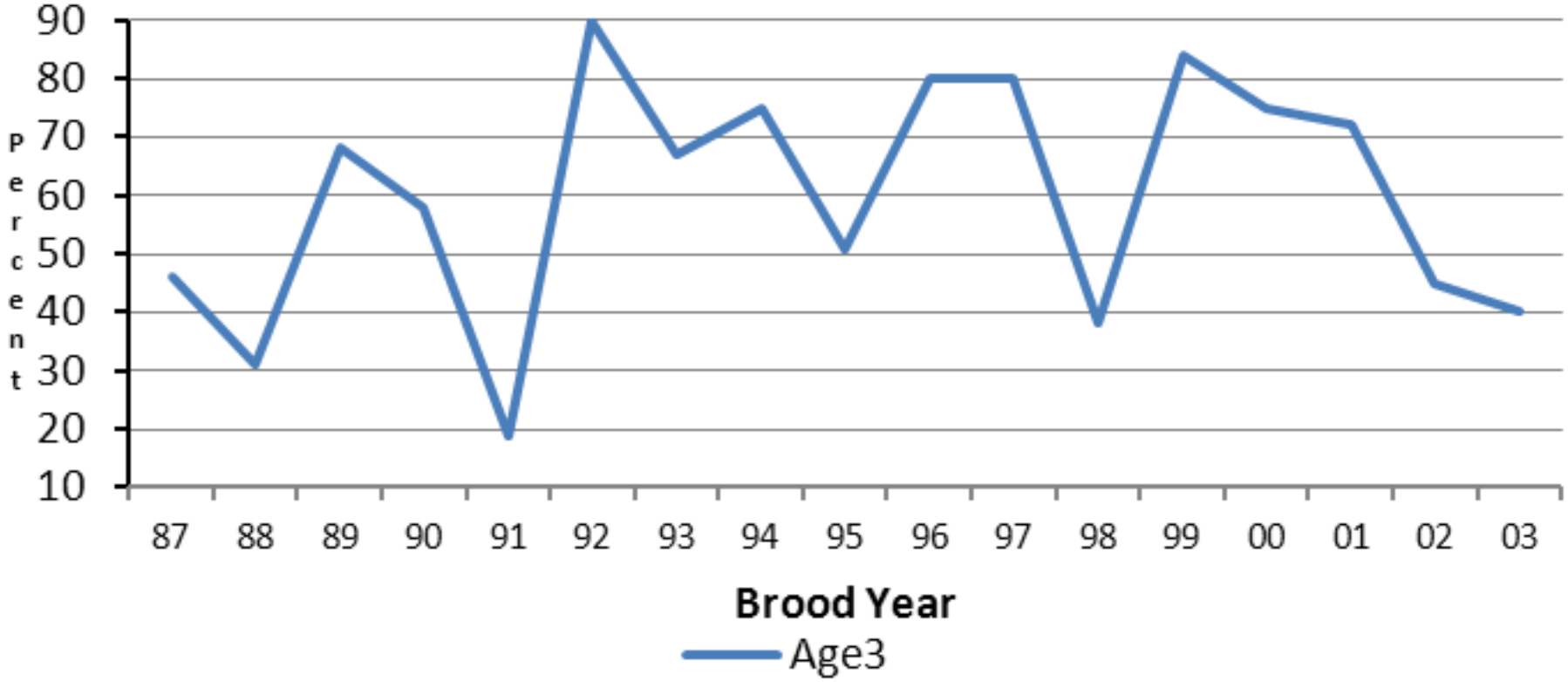

Little White Salmon NFH coho
Percent of Cohort as Jacks
Percent
30
20
10
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00
Brood Year
Jacks


Little White Salmon NFH coho
Percent of Cohort as Jacks
Percent
30
20
10
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00
Brood Year
Jacks

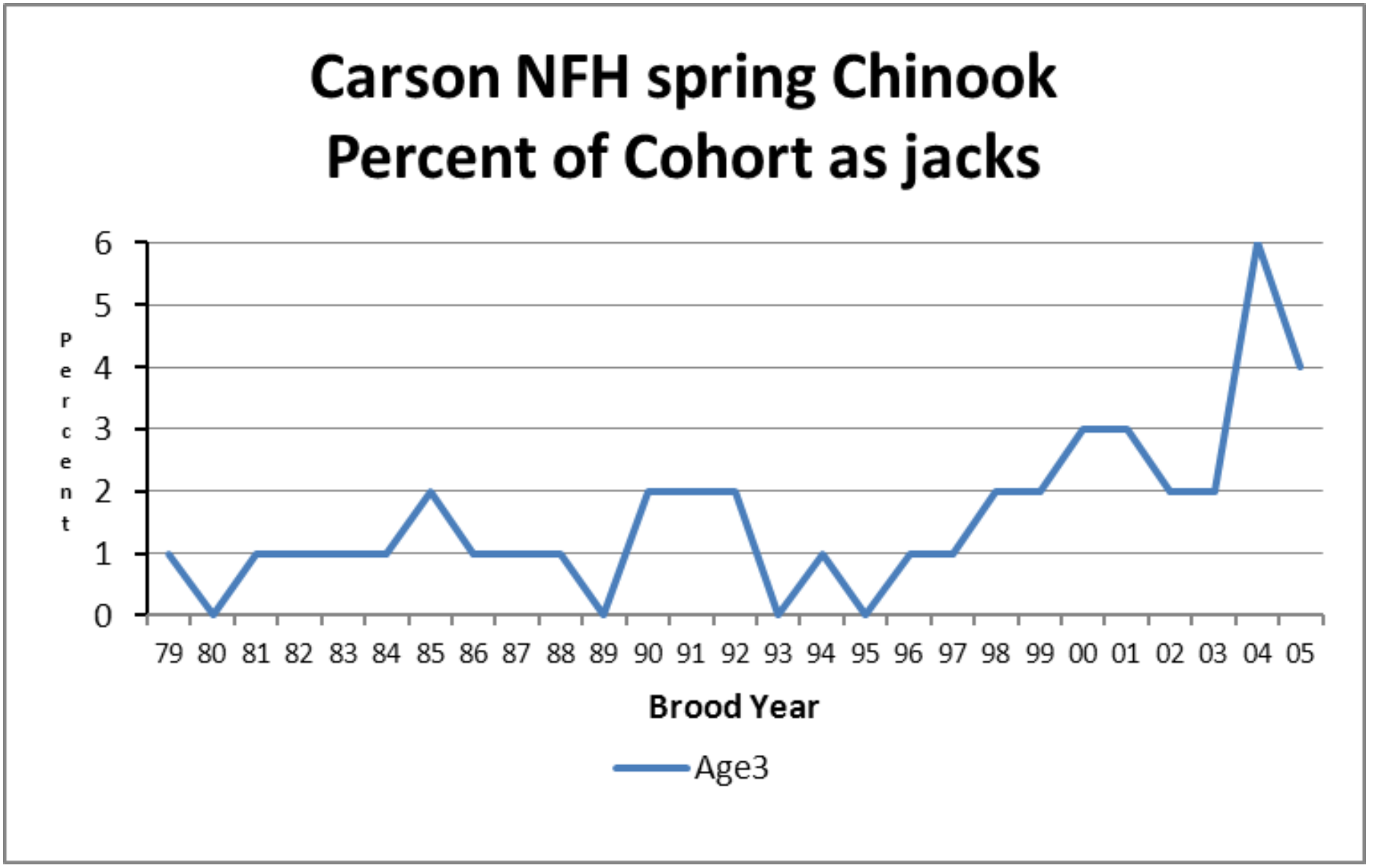

Eagle Creek NFH coho
Percent of Cohort as Jacks
Percent
40
30
20
10
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07
Brood Year
Jacks

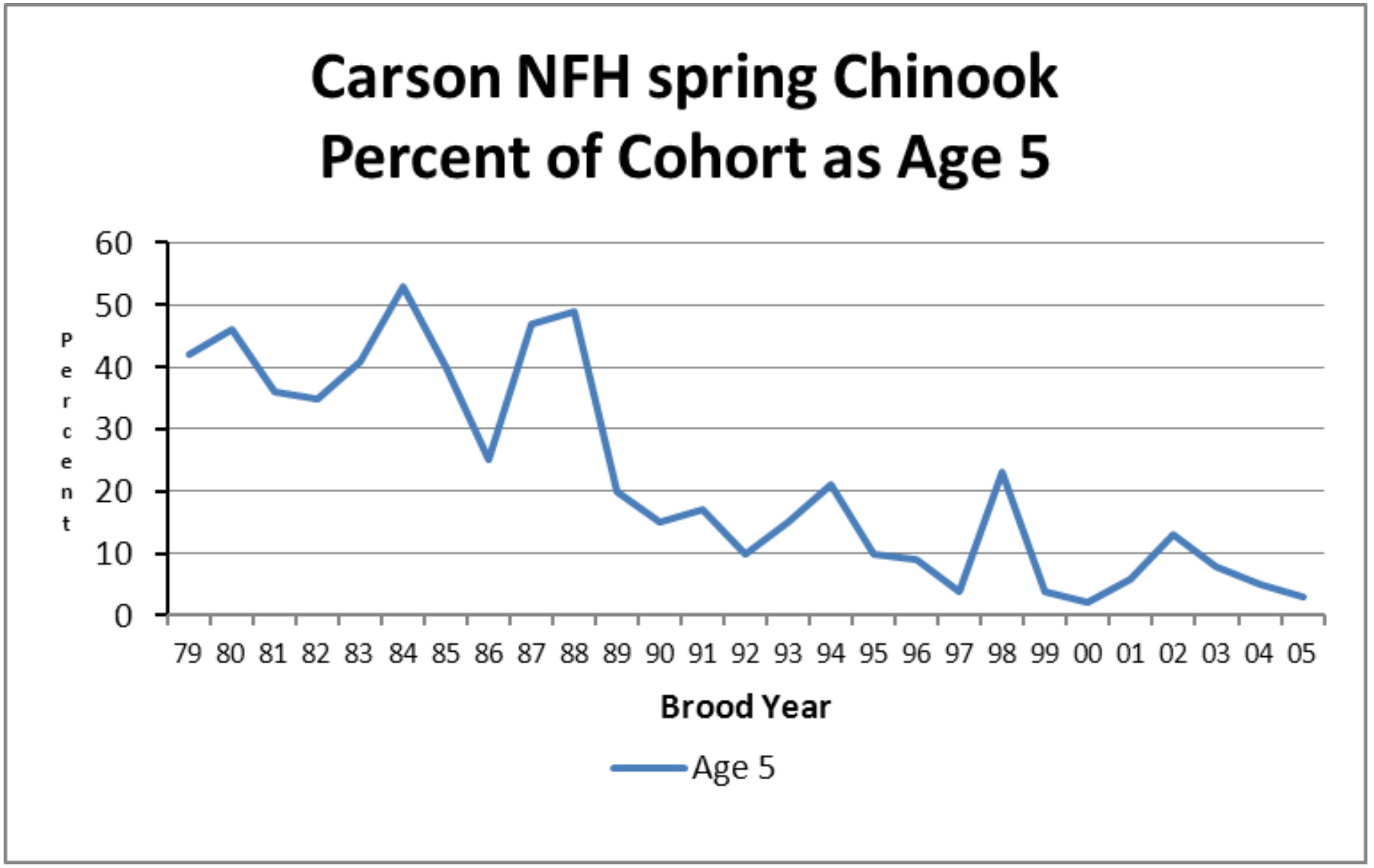

Length of Eagle Creek NFH winter Steelhead Age3
Fork Length Cm
90
85
80
75
70
65
60
55
50
45
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Return Year
Mean
Minimum
Maximum

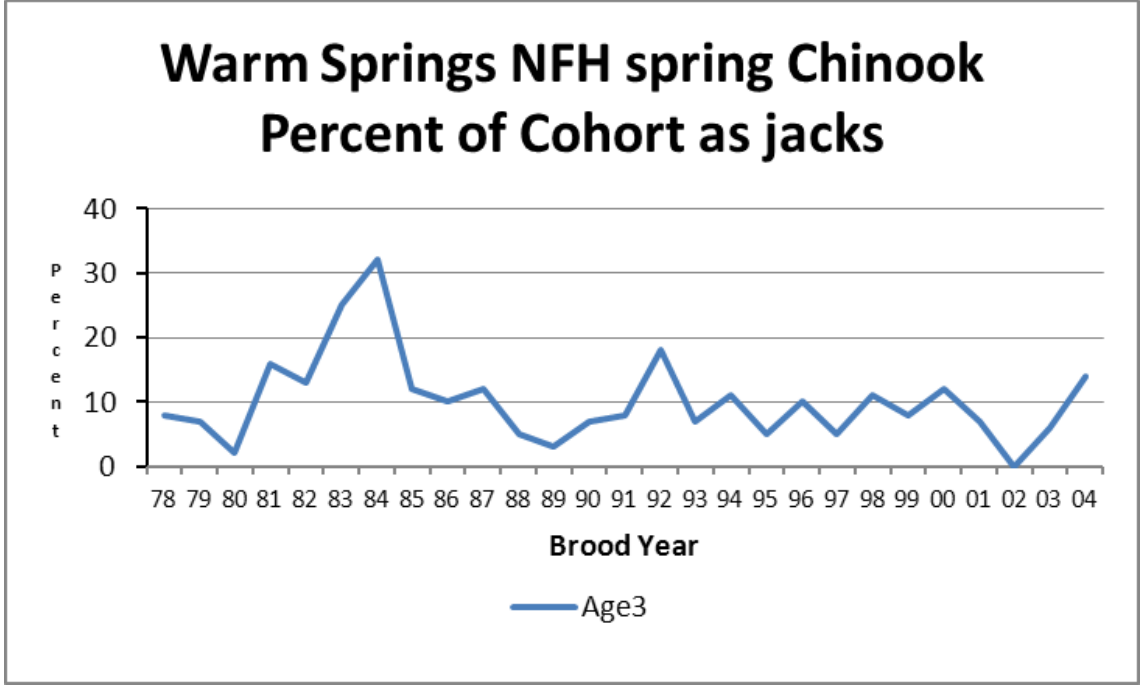
Eagle Creek NFH winter Steelhead Percent of Cohort as Age3

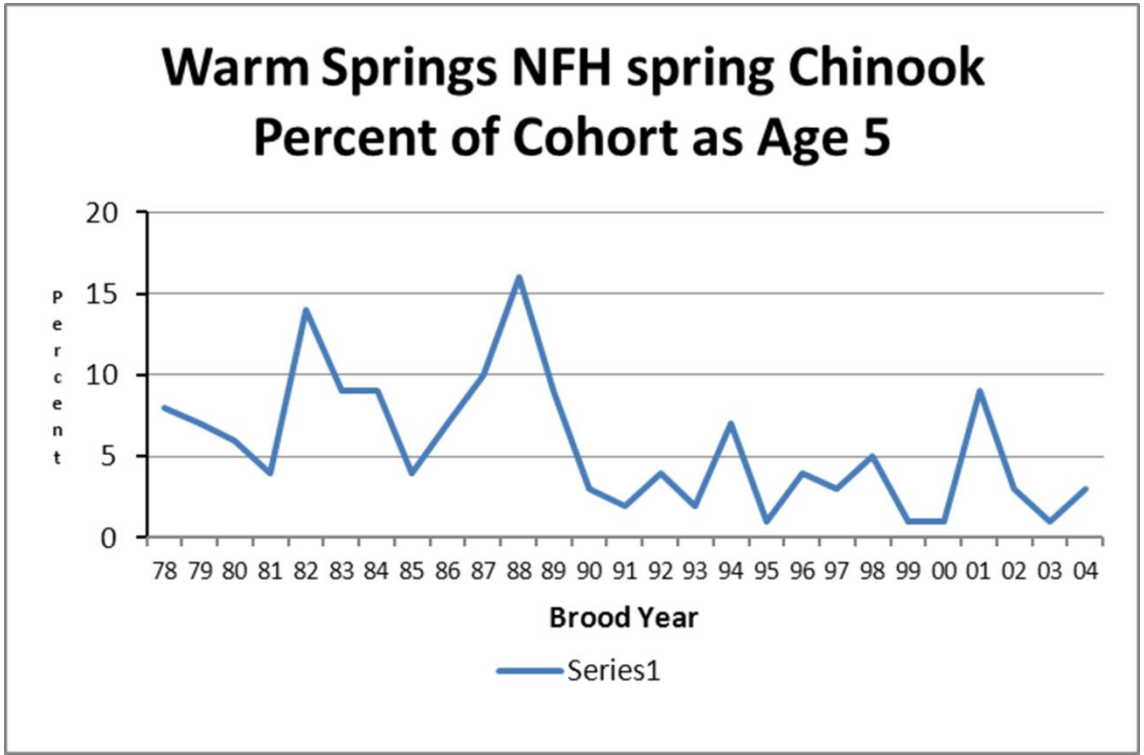


The increase in Age3 fish is at the expense of which other age class?


Carson NFH spring Chinook
Percent of Cohort as jacks
Percent
0
1
2
3
4
5
6
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
Brood Year
Age3

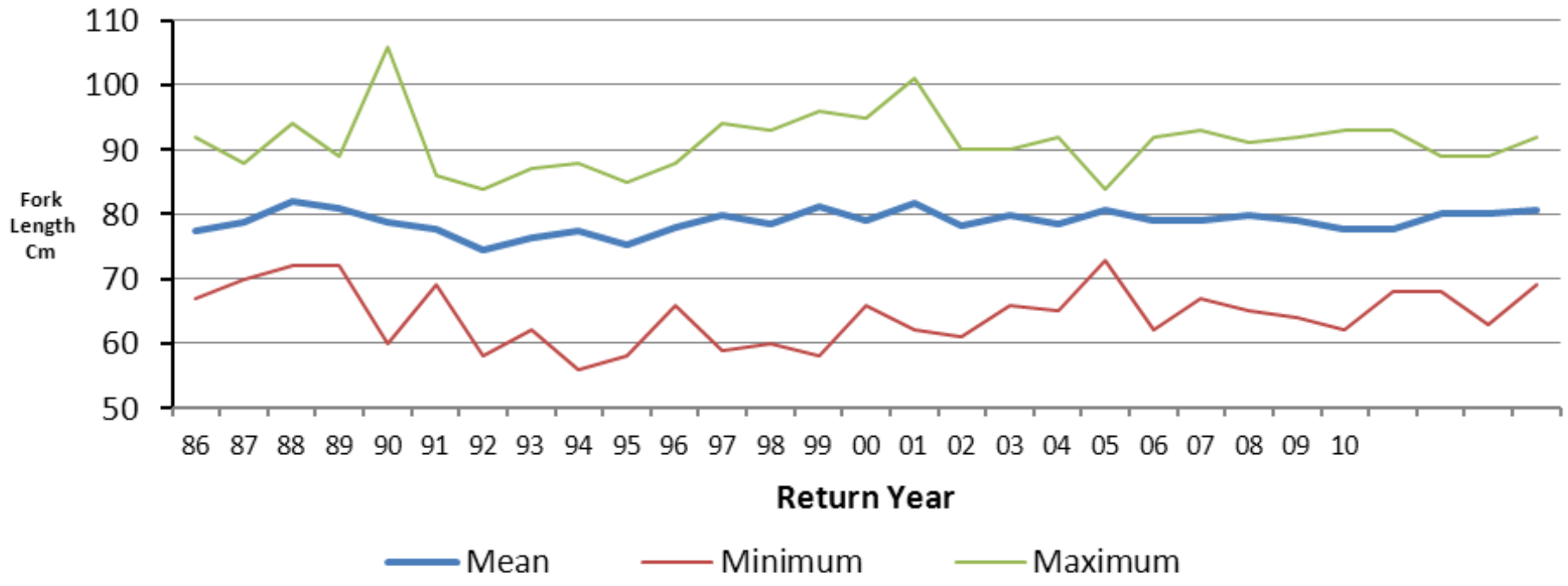

Carson NFH spring Chinook
Percent of Cohort as Age 5
Percent
60
50
40
30
20
10
0
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
Brood Year
Age 5


Warm Springs NFH spring Chinook
Percent of Cohort as jacks
Percent
40
30
20
10
0
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Brood Year
Age3

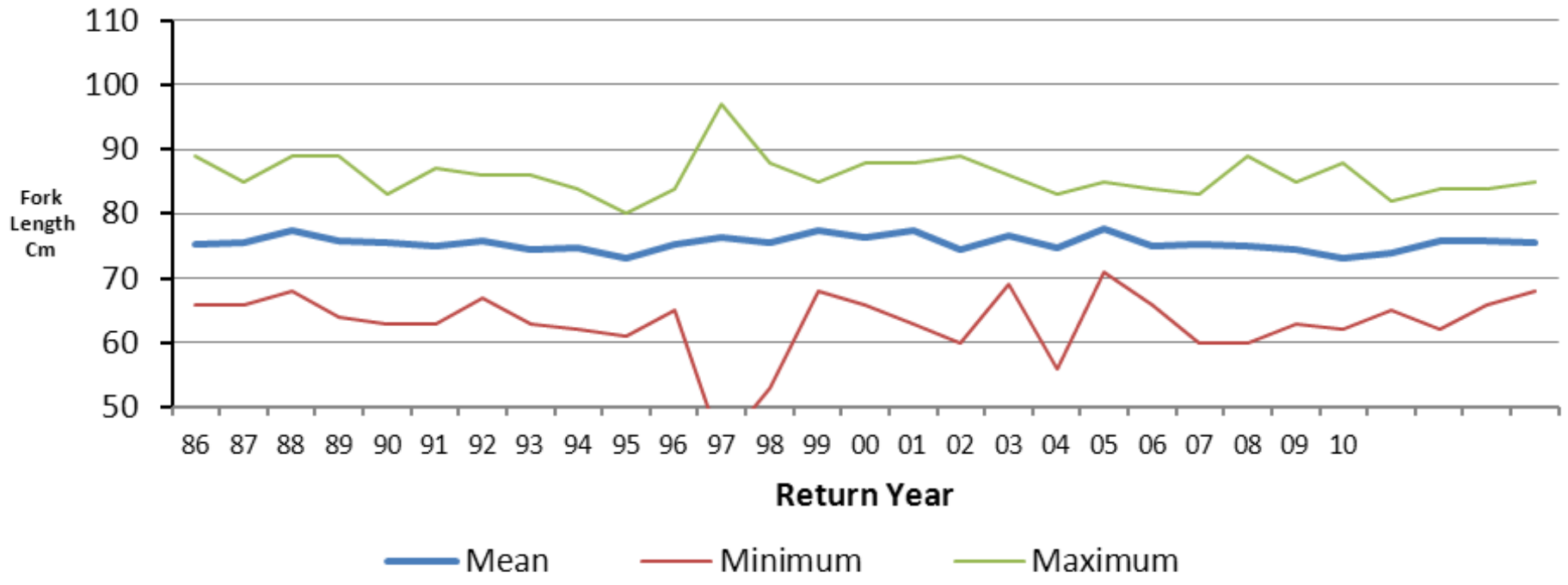

Warm Springs NFH spring Chinook
Percent of Cohort as Age 5
Percent
20
15
10
5
0
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
Brood Year
Series1

What about the size of Age4 fish?

Carson NFH spring Chinook Age 4 males

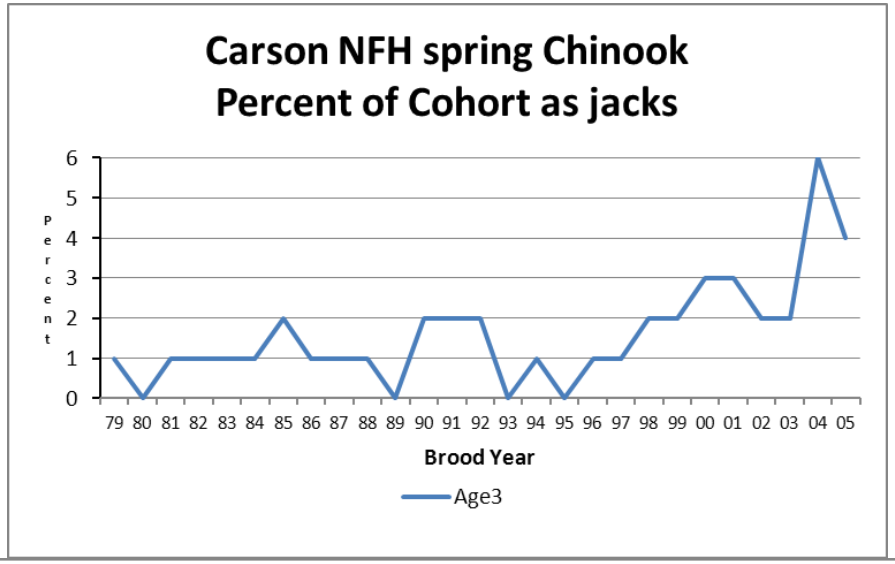


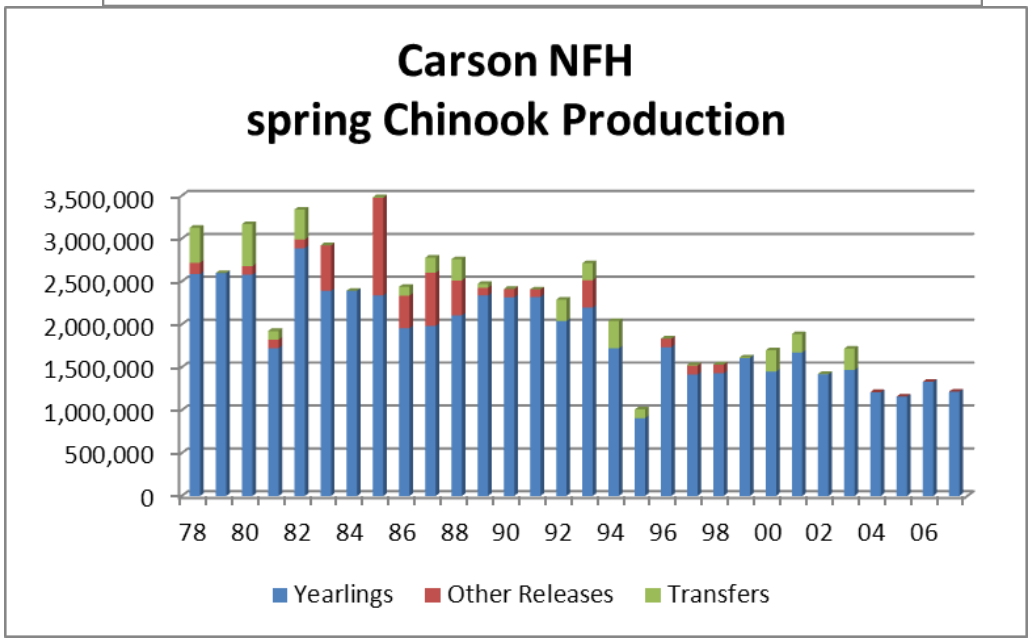
Carson NFH spring Chinook Age 4 females



Are there any likely causes for changes noted?

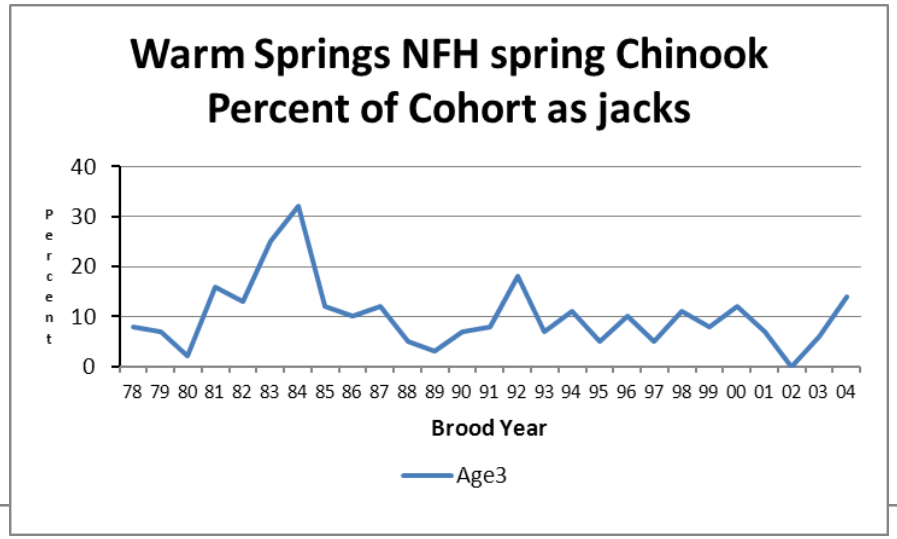
at Carson we see an increase of jacks

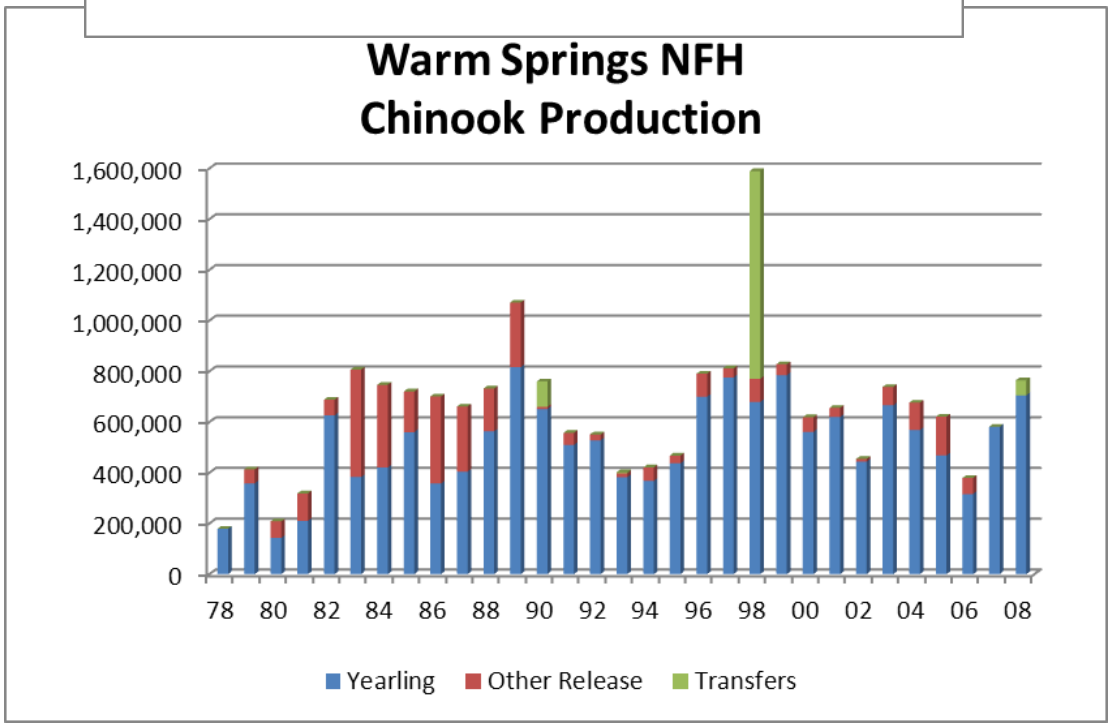




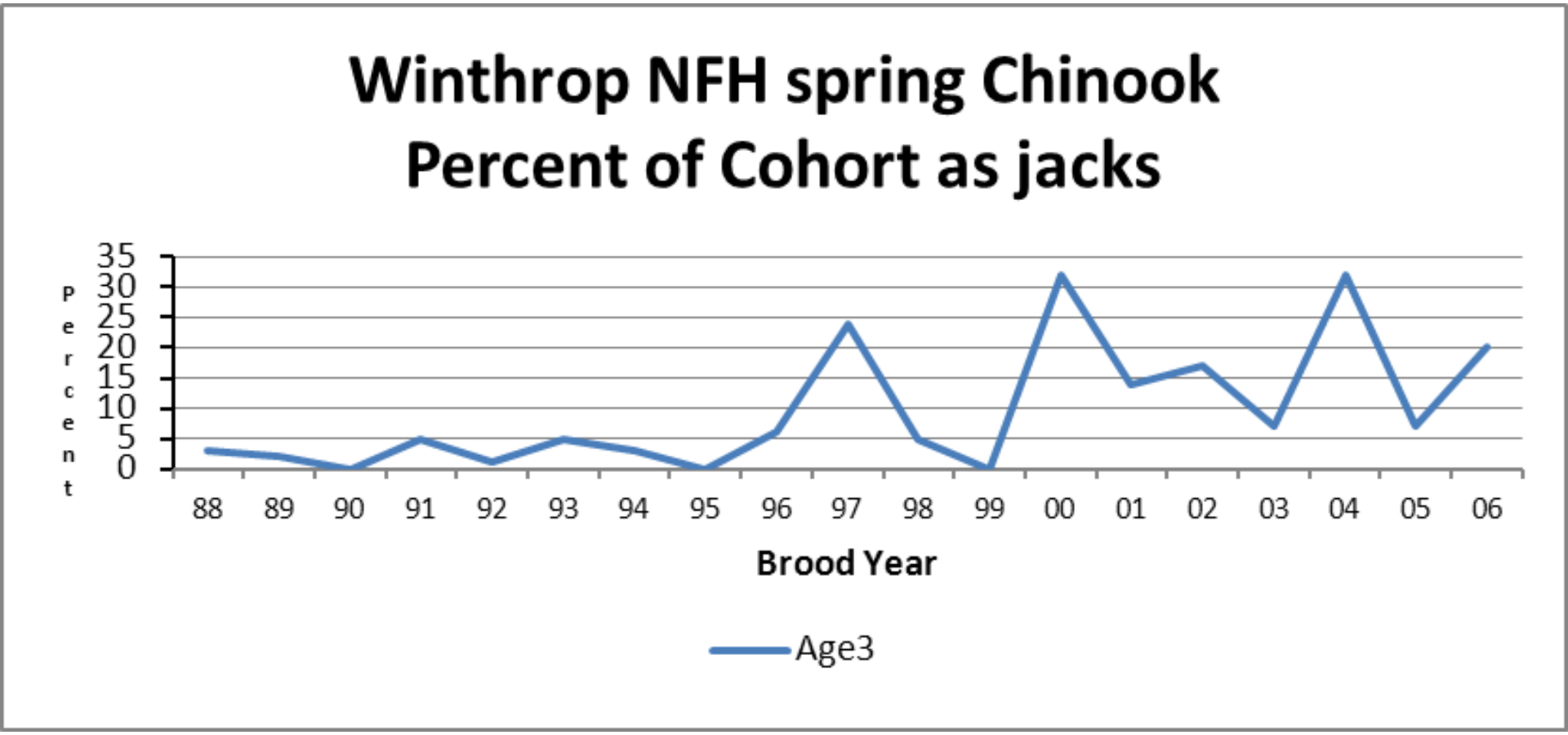
corresponding to a decrease in production

at Warm Springs we see a decrease of jacks



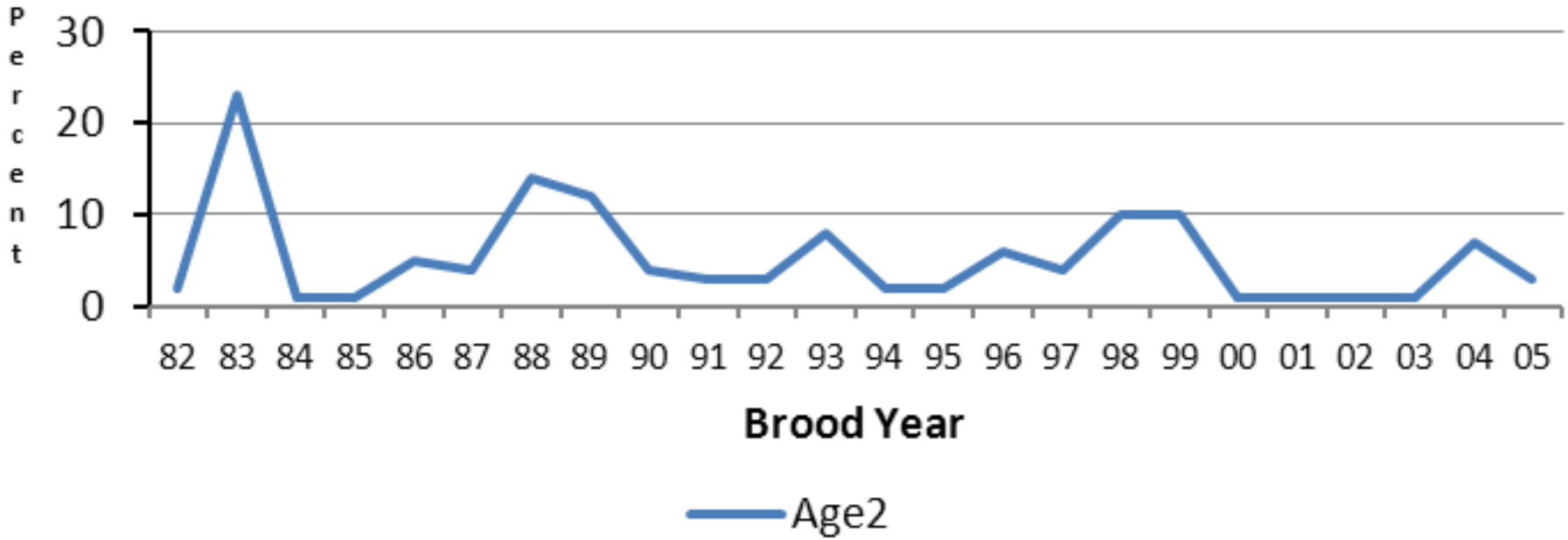


at Winthrop we see an increase of jacks



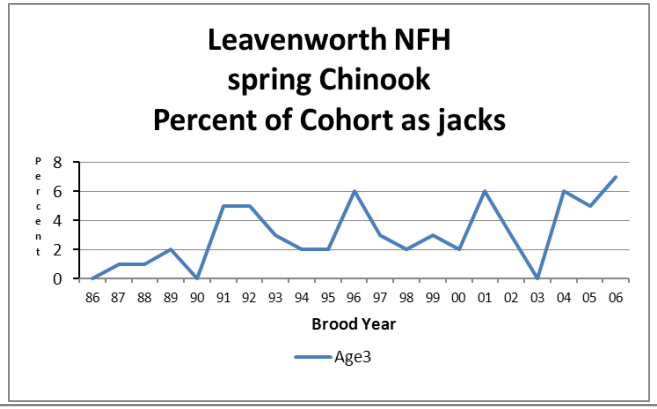
Changed from “Carson stock” to “Methow stock”

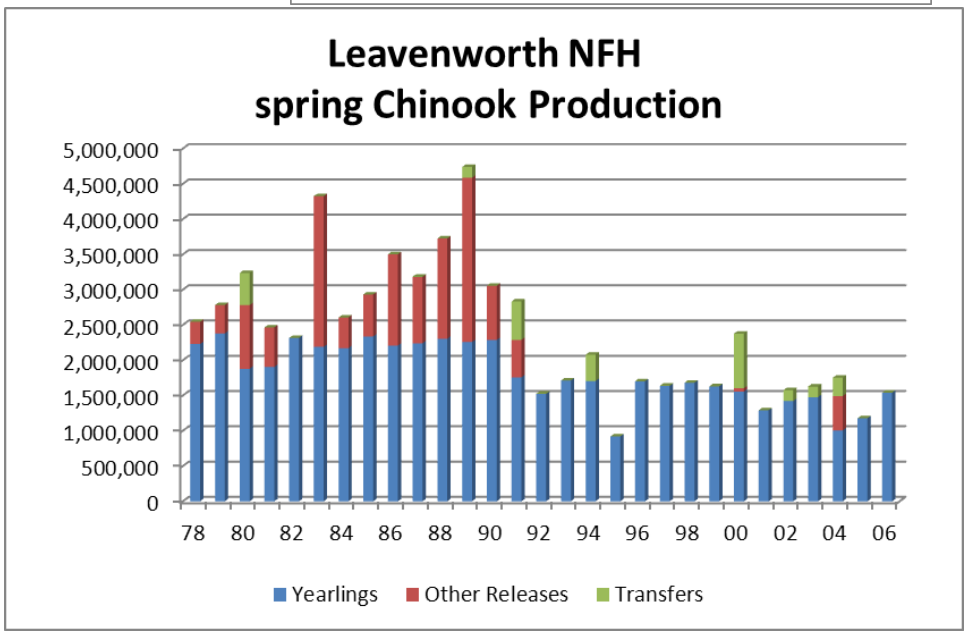
Little White Salmon NFH upriver bright fall Chinook Percent of Cohort as jacks



Little White tried
Extended rearing releases

at Leavenworth we see an increase of jacks

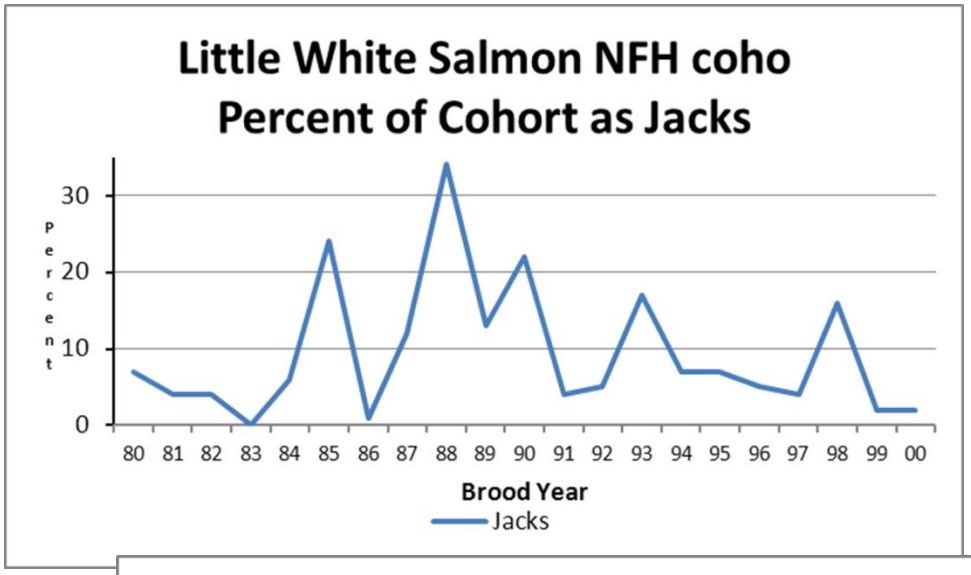


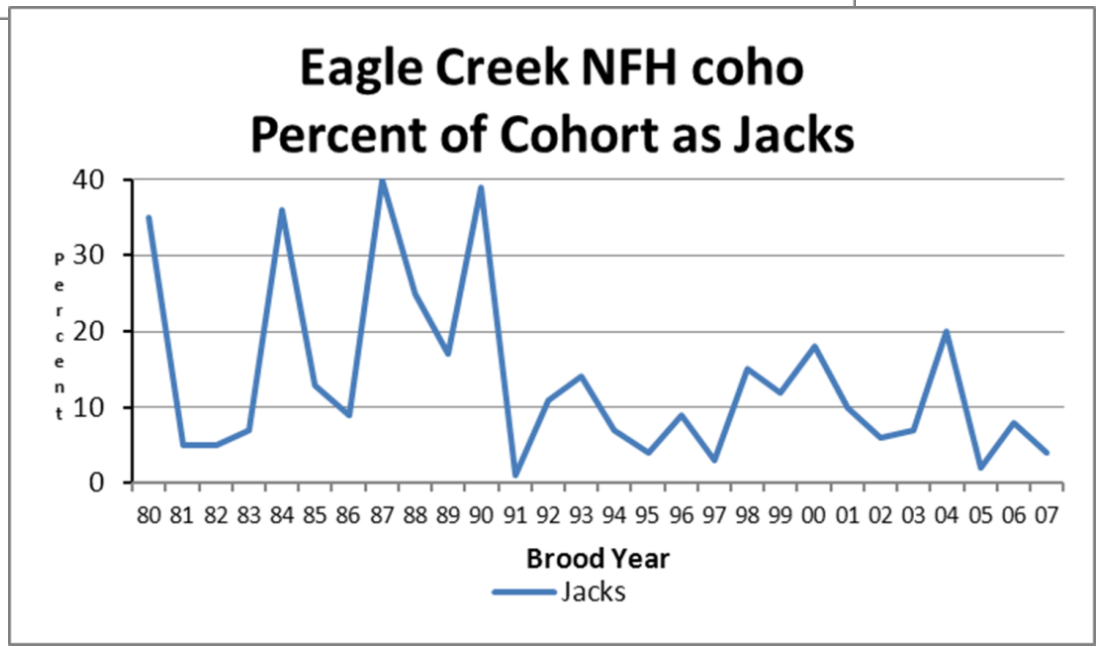


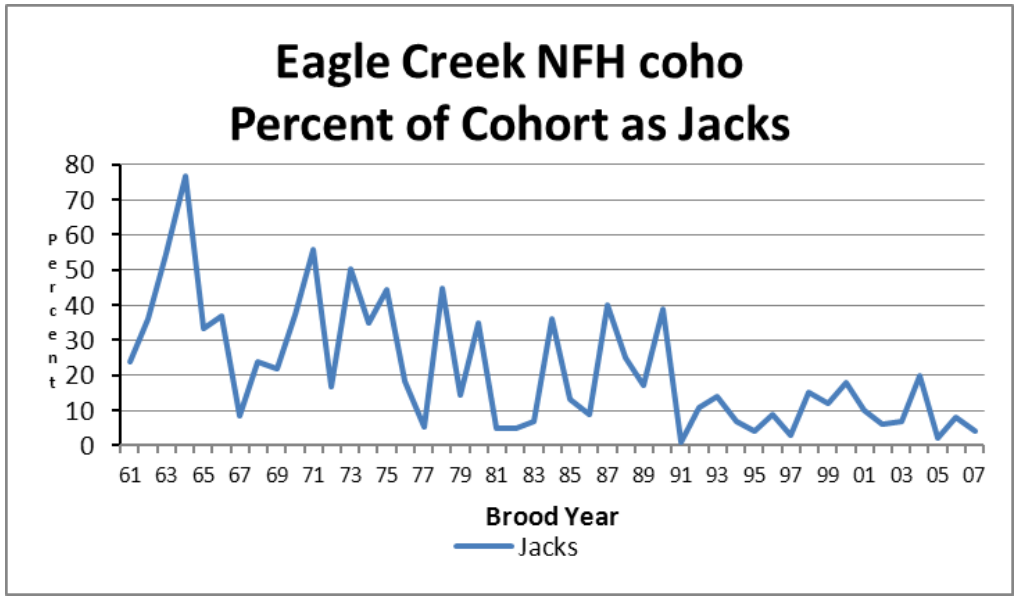
Cessation of a fall release may have resulted in an increase in the percentage of jacks in a cohort at two hatcheries,

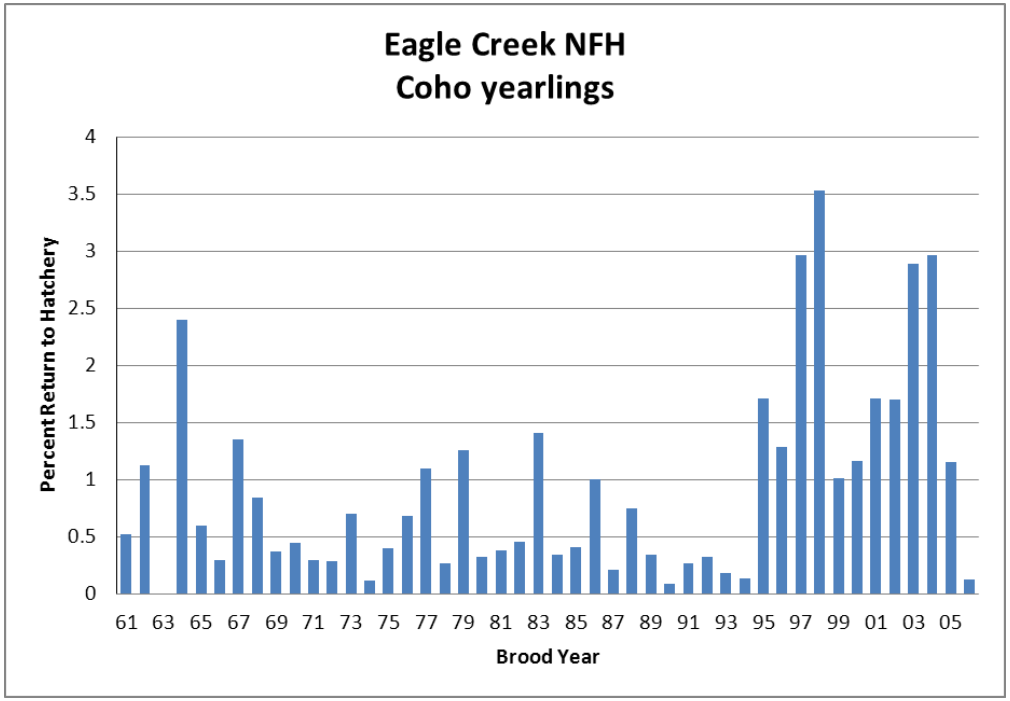
and may have resulted in a decrease at a third hatchery.

Is there a relationship between the number of jacks in a cohort and survival rate?

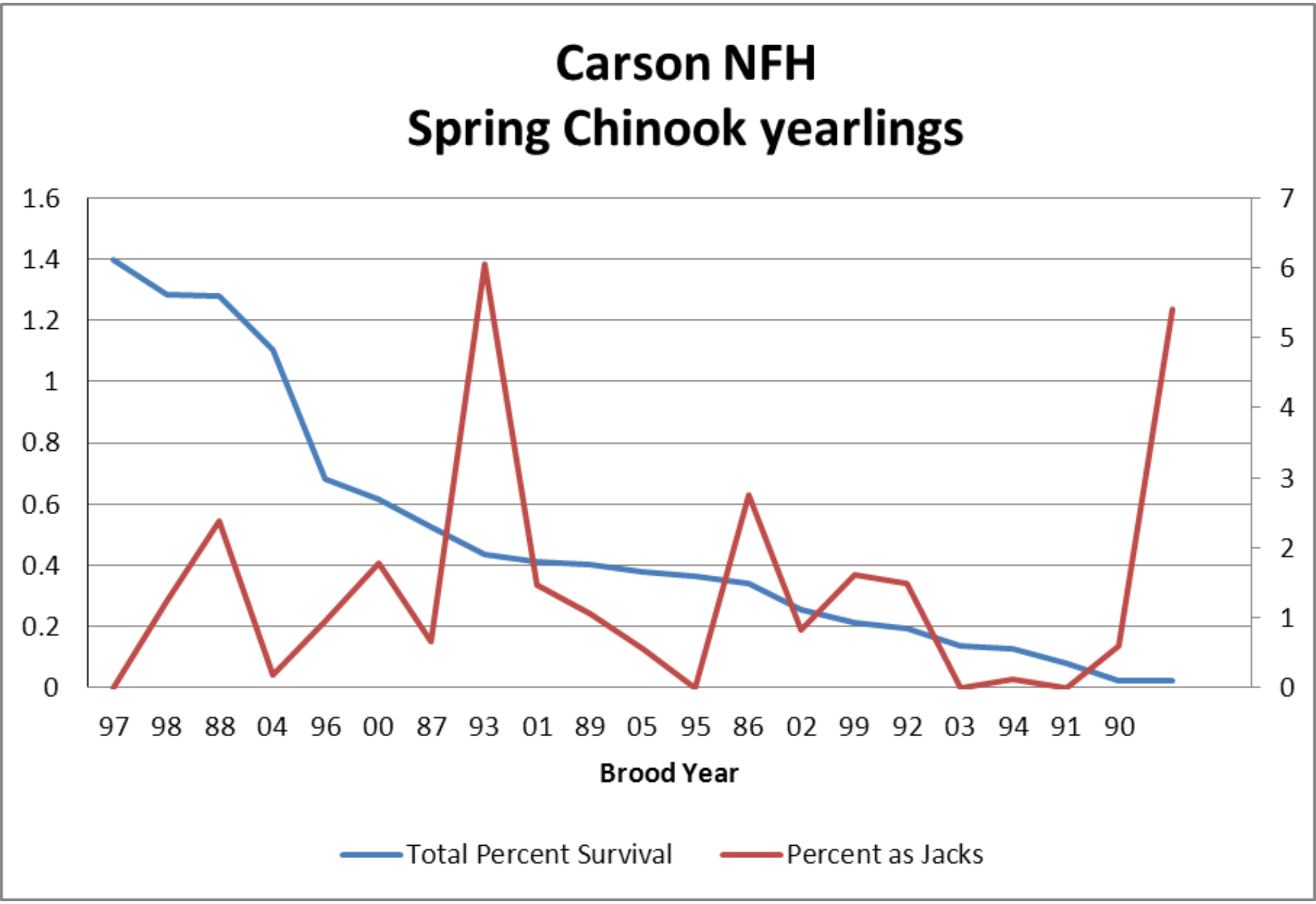

Little White Salmon NFH coho
Percent of Cohort as Jacks
Percent
30
20
10
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00
Brood Year
Jacks

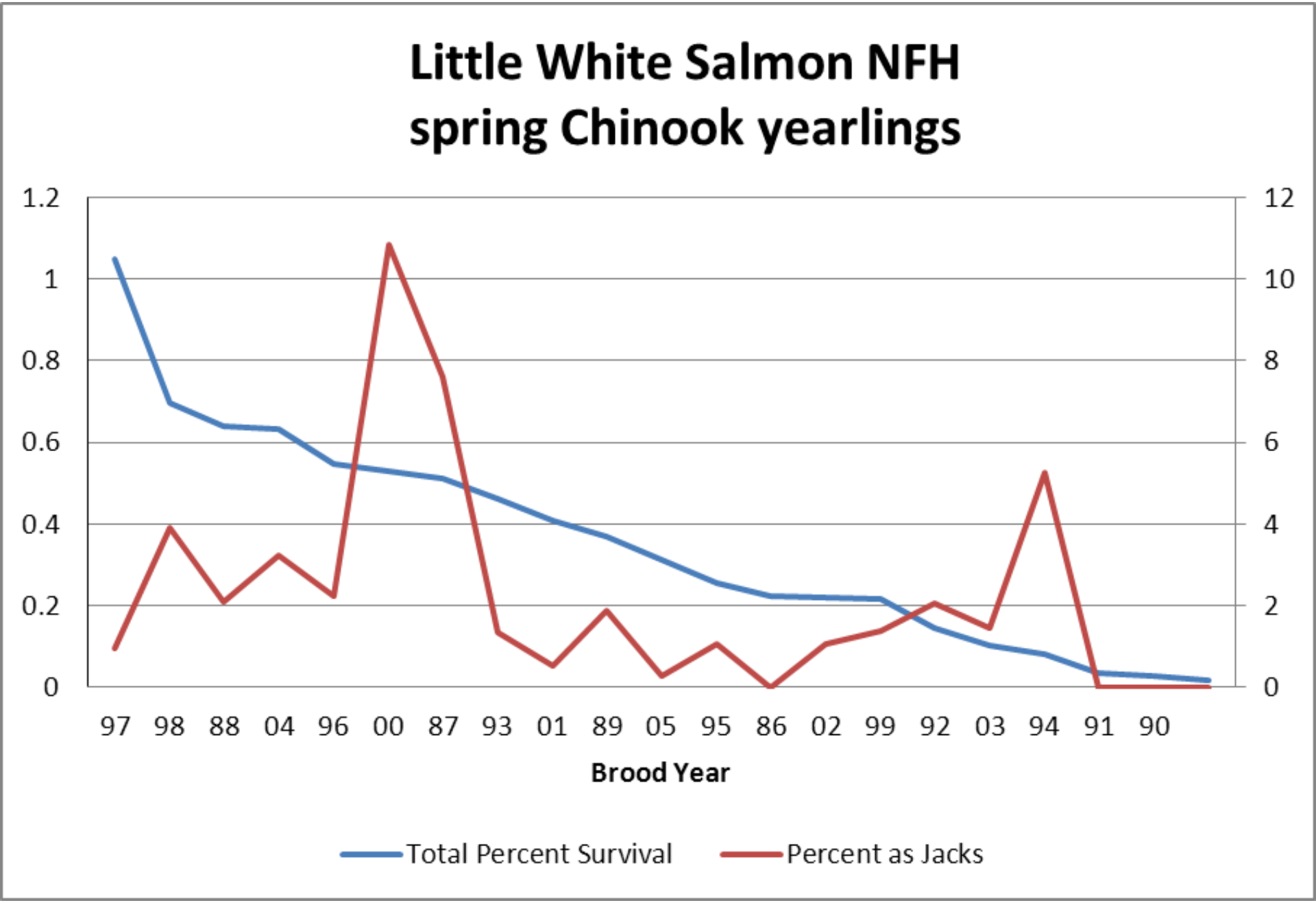

Eagle Creek NFH coho
Percent of Cohort as Jacks
Percent
40
30
20
10
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07
Brood Year
Jacks

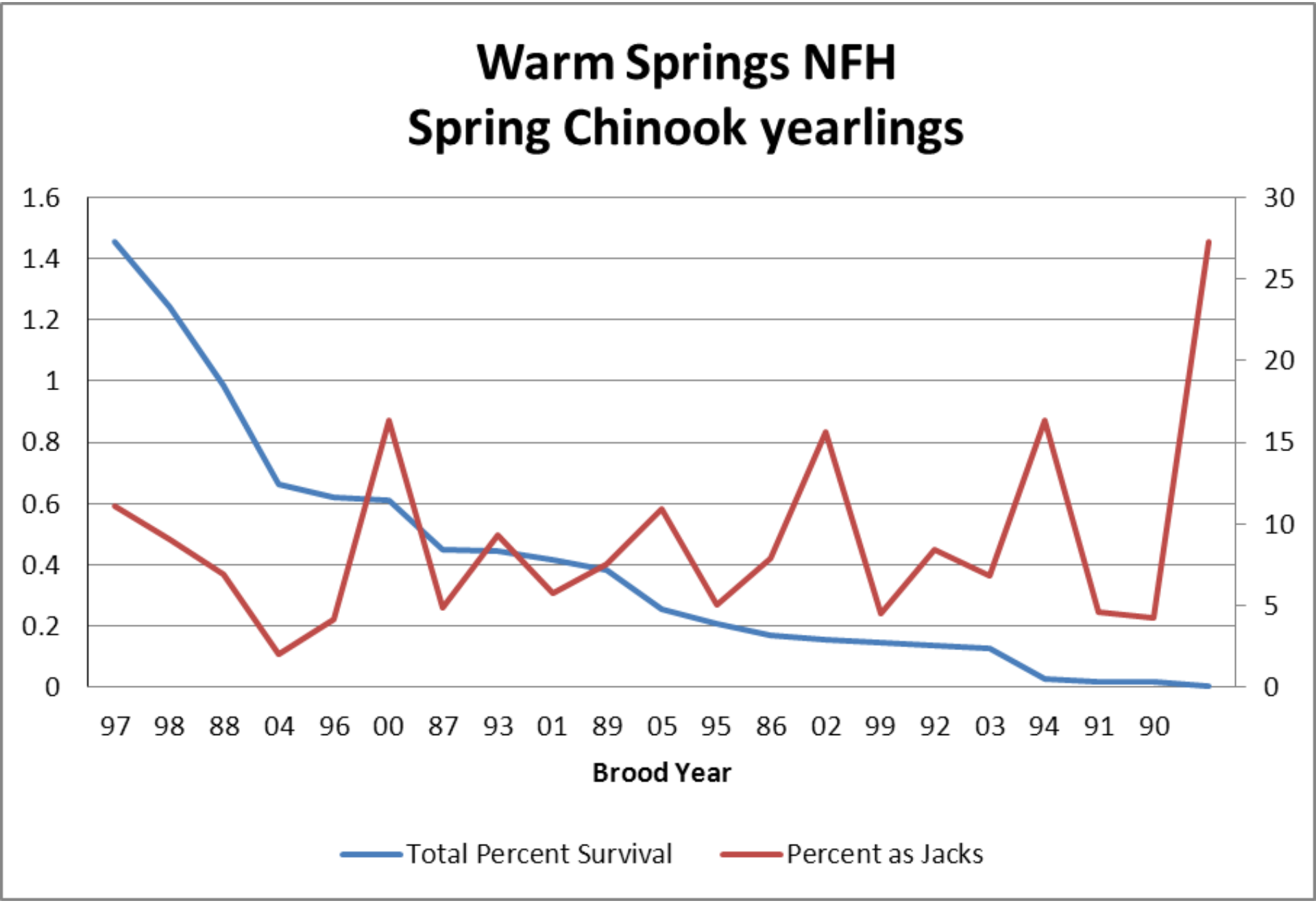

Eagle Creek NFH coho
Percent of Cohort as Jacks
Percent
80
70
60
50
40
30
20
10
0
61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05 07
Brood Year
Jacks

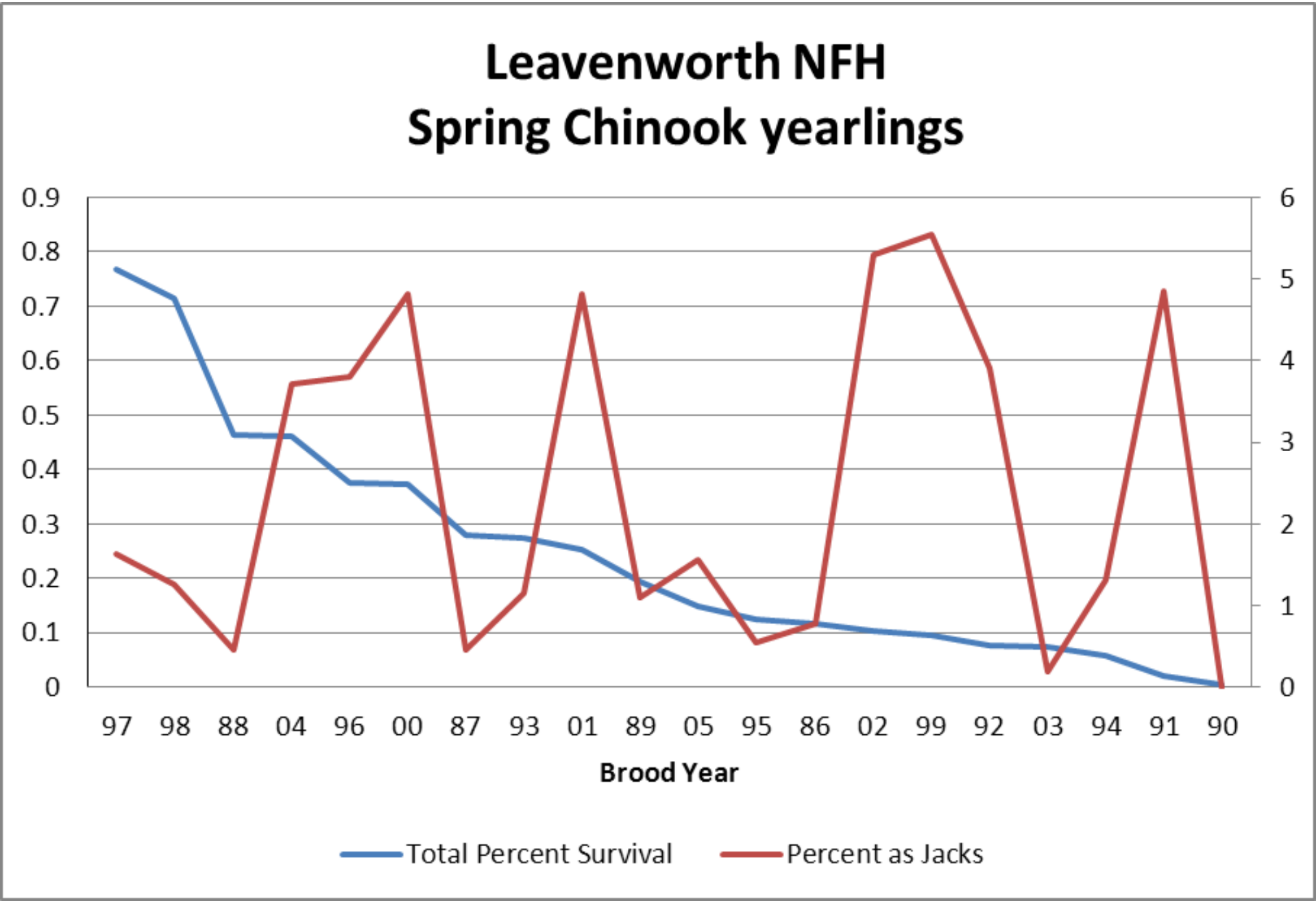

Eagle Creek NFH
Coho yearlings
Percent Return to Hatchery
4
3.5
3
2.5
2
1.5
1
0.5
0
61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05
Brood Year

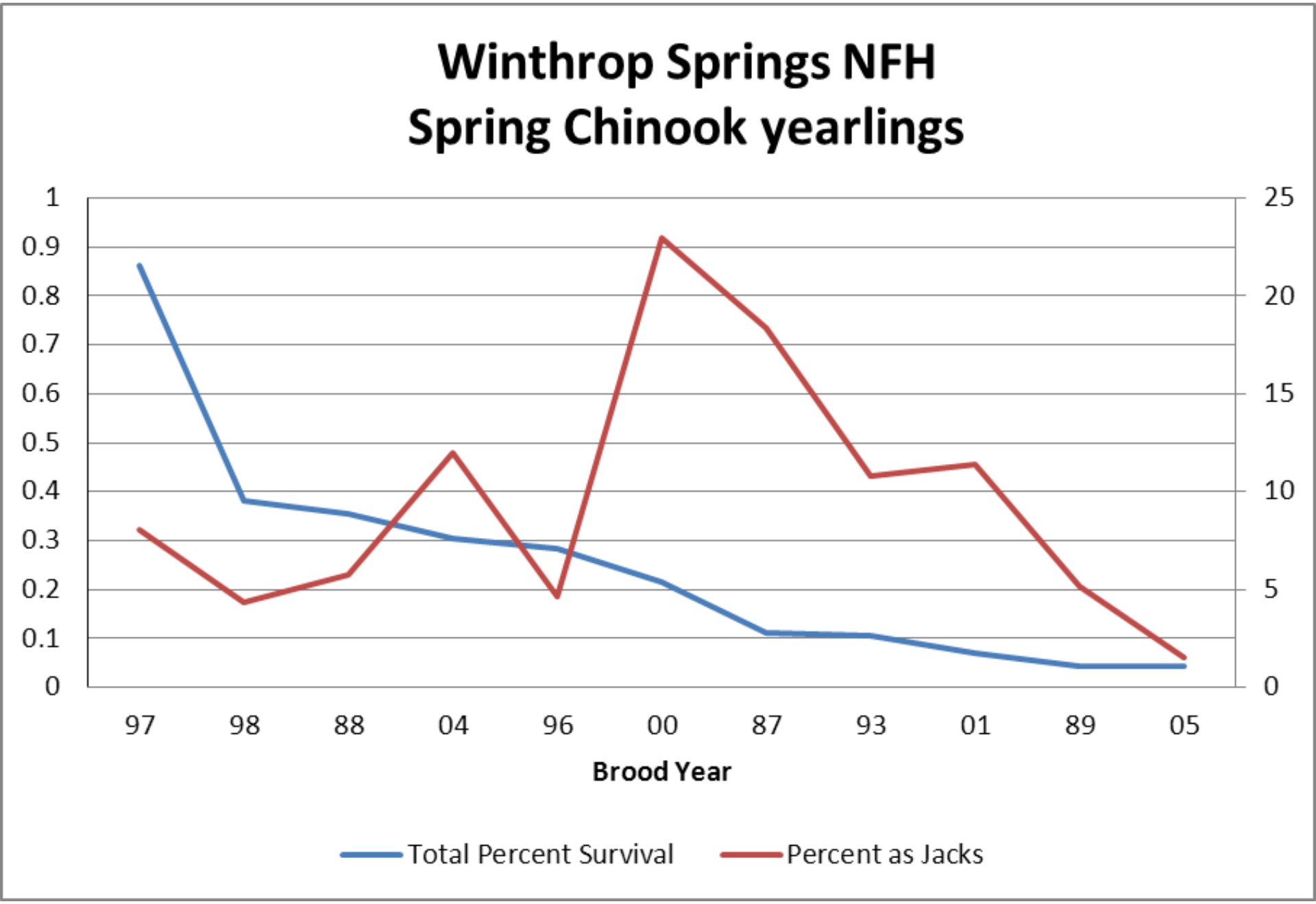
Survival in Descending Order, and Percent of Cohort as Jacks

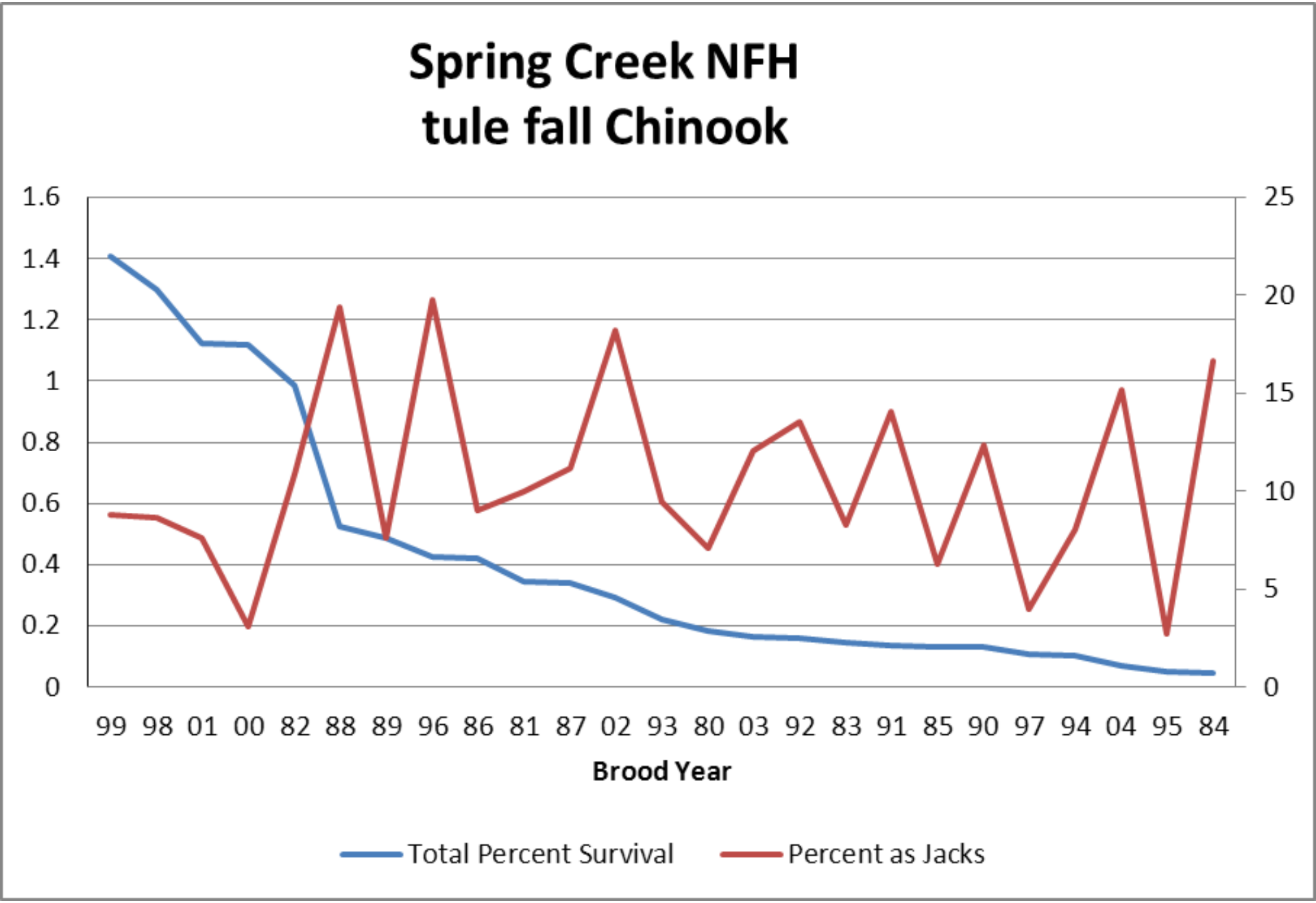

Carson NFH
Spring Chinook yearlings
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
7
6
5
4
3
2
1
0
97 98 88 04 96 00 87 93 01 89 05 95 86 02 99 92 03 94 91 90
Brood Year
Total Percent Survival
Percent as Jacks

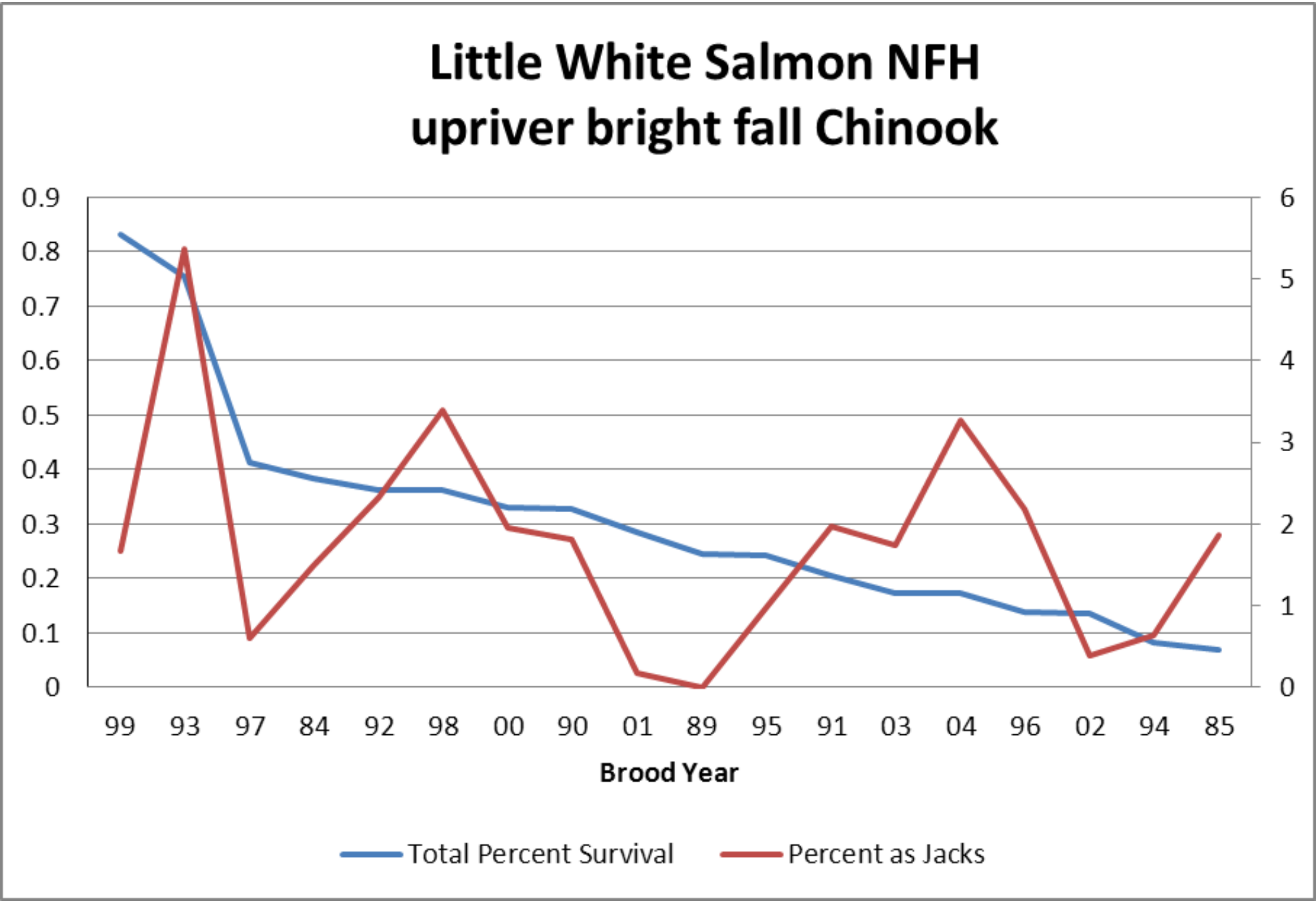

Little White Salmon NFH
spring Chinook yearlings
1.2
1
0.8
0.6
0.4
0.2
0
12
10
8
6
4
2
0
97 98 88 04 96 00 87 93 01 89 05 95 86 02 99 92 03 94 91 90
Brood Year
Total Percent Survival
Percent as Jacks

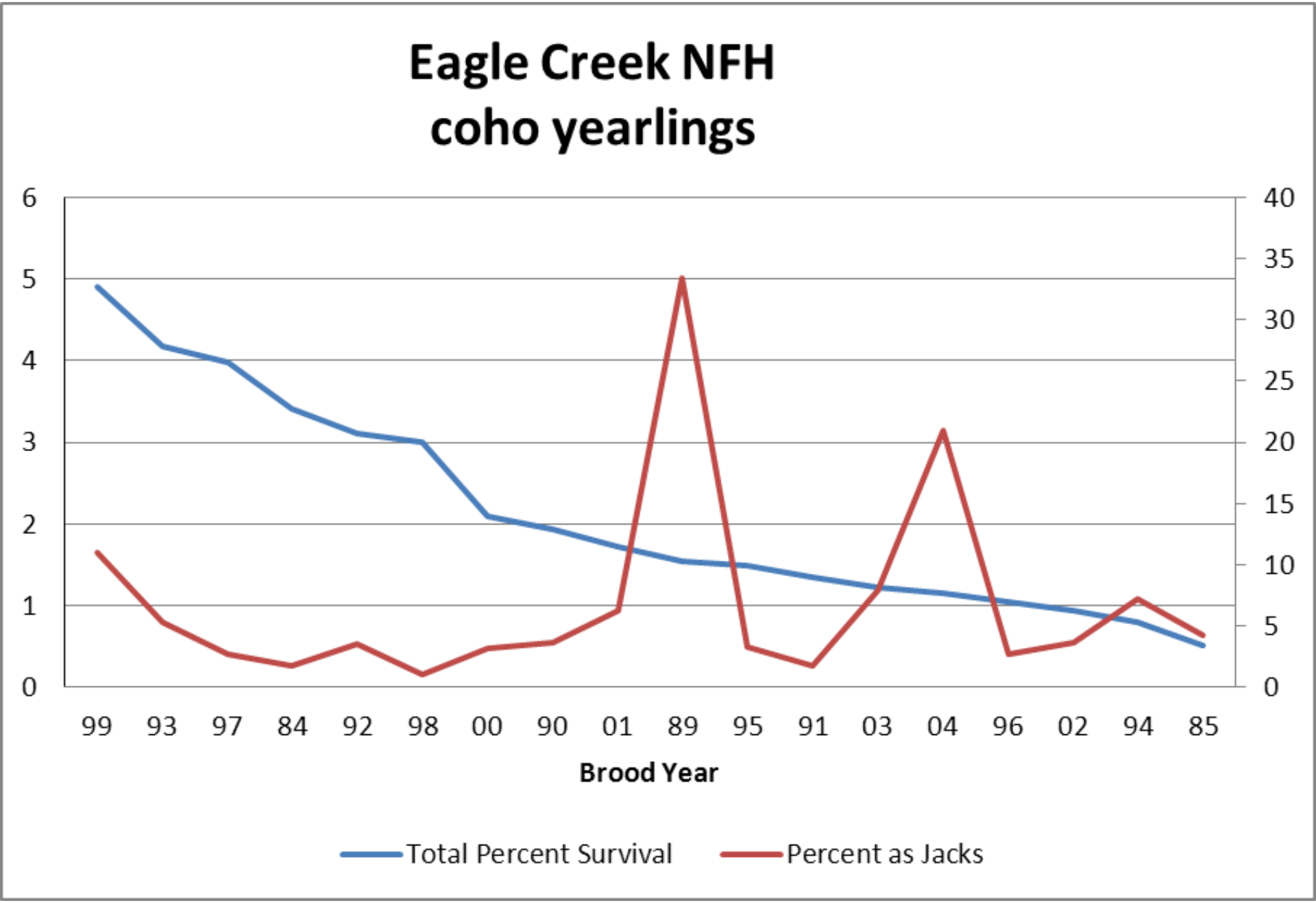

Warm Springs NFH
Spring Chinook yearlings
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
30
25
20
15
10
5
0
97 98 88 04 96 00 87 93 01 89 05 95 86 02 99 92 03 94 91 90
Brood Year
Total Percent Survival
Percent as Jacks


Leavenworth NFH
Spring Chinook yearlings
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6
5
4
3
2
1
0
97 98 88 04 96 00 87 93 01 89 05 95 86 02 99 92 03 94 91 90
Brood Year
Total Percent Survival
Percent as Jacks


Winthrop Springs NFH
Spring Chinook yearlings
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
25
20
15
10
5
0
97
98
88
04
96
00
87
93
01
89
05
Brood Year
Total Percent Survival
Percent as Jacks


Spring Creek NFH
tule fall Chinook
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
25
20
15
10
5
0
99 98 01 00 82 88 89 96 86 81 87 02 93 80 03 92 83 91 85 90 97 94 04 95 84
Brood Year
Total Percent Survival
Percent as Jacks


Little White Salmon NFH
upriver bright fall Chinook
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6
5
4
3
2
1
0
99 93 97 84 92 98 00 90 01 89 95 91 03 04 96 02 94 85
Brood Year
Total Percent Survival
Percent as Jacks


Eagle Creek NFH
coho yearlings
6
5
4
3
2
1
0
40
35
30
25
20
15
10
5
0
99 93 97 84 92 98 00 90 01 89 95 91 03 04 96 02 94 85
Brood Year
Total Percent Survival
Percent as Jacks

Conclusions

- Taken as a whole, there has been no overall increase in the size of spring Chinook jacks returning to National Fish Hatcheries since the early late 1980s / early1990s

- Taken as a whole, there has been no overall change in the proportion of spring Chinook returning to national Fish Hatcheries as Jacks since the early late 1980s / early1990s

- Most observed changes coincide with the cessation of fall release programs, reduced production / reduced density, or changing to a different stock

- Also noted differences among species and runs